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ABSTRACT

This is the fifth report in a series on the educational personnel system in the United States. This report is an analysis of the paths by which individuals are attracted to, trained for, enter, and reenter the teaching profession. A review of previous analyses of the teacher market is followed by development of a theoretical model of occupational choice that identifies the influence of economic factors on an individual's career decision. The model is estimated cross-sectionally, using currently available data on teacher production rates by State. Results suggest that a) previous studies have overestimated the annual supplies of new teachers; b) the teacher surplus is likely to peak and then begin to decline in the near future; c) if anticipated declines materialize, the surplus is likely to end in the early 1980s; and d) there is a distinct possibility that the system will "overrespond" to the surplus, in the sense that a significant teacher shortage will follow. (Author/JA)

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ANALYSIS OF THE EDUCATIONAL PERSONNEL SYSTEM: V. THE SUPPLY OF ELEMENTARY AND SECONDARY TEACHERS

PREPARED FOR THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

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PREFACE

Under Contract OEC-0-71-2533(099) with the U.S. Office of Education, The Rand Corporation has been conducting an analysis of the educational personnel system in the United States. This is the fifth in a series of reports presenting details of Rand's research. This report examines the supply of teachers in order to investigate the likely future trends in teacher supply and, consequently, in teacher surplus. The analysis addresses four main topics: the concept of supply as it applies to the educational personnel system, the strengths and weaknesses of the currently available evidence concerning the supply of teachers, the factors that influence teacher production, and the likely future trends in the supply of teachers.

The other reports in this series are:

David Greenberg and John McCall, *Analysis of the Educational Personnel System: I. Teacher Mobility in San Diego*, R-1071-HEW, January 1973.

David Greenberg and John McCall, *Analysis of the Educational Personnel System: II. A Theory of Labor Mobility with Application to the Teacher Market*, R-1270-HEW, August 1973.

Stephen J. Carroll, *Analysis of the Educational Personnel System: III. The Demand for Educational Professionals*, R-1308-HEW, October 1973.

Emmett Keeler, *Analysis of the Educational Personnel System: IV. Teacher Turnover*, R-1325-HEW, October 1973.

Kenneth F. Ryder, Jr., *Analysis of the Educational Personnel System: VI. Staffing Patterns in U.S. Local Public Schools*, R-1342-HEW, February 1974.

David Greenberg and John McCall, *Analysis of the Educational Personnel System: VII. Teacher Mobility in Michigan*, R-1343-HEW, February 1974.

Stephen J. Carroll et al., *Analysis of the Educational Personnel System: VIII. Overview and Summary*, R-1344-HEW, February 1974.

SUMMARY

The teacher surplus that emerged during the late 1960s confronted the educational community with a number of important policy issues. The ability of the educational community to address these issues, however, has been seriously affected by the lack of information, or, more accurately, by the abundance of conflicting information regarding the nature and extent of the problem. This study attempts to contribute to the development of appropriate responses to the teacher surplus through a detailed theoretical and empirical analysis of the supply of teachers.

THE CONCEPT OF TEACHER SUPPLY

Our analysis begins with an overview of the U.S. educational manpower system, with an emphasis on those subsystems that produce new additions to the stock of trained educational manpower. Individuals are attracted to, trained for, enter, and reenter the teaching profession along a variety of different paths. We examine these paths in the context of an aggregate flow model of the educational personnel system. We go on to examine the three basic manpower pools from which a local educational agency can recruit professional staff, each of which gives rise to a supply of educational professionals:

- The stock of personnel employed in the education sector,
- The reserve pool, and
- The stock of new graduates eligible to teach.

The individuals in the pool of eligible new graduates subsequently enter either the pool of professionals employed in education or the reserve pool, depending upon whether or not they seek a teaching position, and if they do, whether or not they are successful. Entry into the system occurs only via this path. Exits from the system--death, disability, and retirement--occur exogenously in the sense that they are not related to labor market conditions. A variety of factors such as the number of teaching jobs available, school district hiring preferences, the relative attractiveness of a teaching position in comparison to other occupations, and so on will affect the distribution of persons between the reserve pool and the pool of professionals employed in education.

An important implication of these remarks is that *the annual size of the pool of eligible new graduates is a key variable* in an analysis of the long-run supply of teachers. In a surplus situation the number of persons employed as teachers is determined by demand. Thus the size of that pool can be estimated from a demand analysis. Given morality rates, disability rates, etc., the size of the reserve pool is then determined as the sum of the sizes of the pools of eligible new graduates in previous years.

PREVIOUS STUDIES OF THE SUPPLY OF TEACHERS

The conceptual analysis of the supply of teachers identifies the parameters that underlie teacher supply and specifies the relationships among them. The next step is to review the available information concerning the supply of teachers. We begin with a review of six previous analyses of the market for teachers, concentrating on the techniques used in each to project the future values of each supply parameter. These analyses were conducted by: the National Education Association (NEA), 1972; the National Center for Educational Statistics (NCES), 1971; Joseph Froomkin and Associates, 1971; Edward Rattner and Associates, 1971; the U.S. Department of Labor (DOL), 1972; and the Commission on Human Resources and Advanced Education (Folger, Astin, and Bayer, 1970).

The available estimates of the supply of classroom teachers are remarkably dissimilar. The differences can be attributed, in part, to the use of different methodologies and different data bases in the various analyses of the supply of teachers. However, we find that most of the variation among the results of the analyses of teacher supply stem from fundamental differences in the concepts of manpower supply used in the studies.

Although there are serious limitations regarding the estimation of a number of the parameters in each study, one assumption made in every study is particularly inappropriate. The available projections of the supply of teachers assume *the teacher production rate--the ratio of college graduates prepared to teach to total college graduates--is constant.* This assumption is based upon the annual NEA reports of teacher education graduates expressed as a percentage of the bachelor's and first professional degree class.

However, the NEA method of calculating the annual teacher production rate is quite misleading. They include all graduates prepared to teach at both the bachelor's and master's degree levels, although the vast majority of master's degrees granted in teacher education are awarded to persons already qualified to teach. Such persons do not represent an increment to the stock of teachers but rather an improvement in the preexisting stock and thus should not be included in the estimation of teacher production.

In the light of these observations, we construct an alternative set of teacher production rates for the period 1966-1972. These rates reflect the annual percentage of the BA degree class that was prepared to teach. They show a distinct downward trend. *There are no instances over the seven-year period in which the rate fails to fall from one year to the next, and the cumulative impact is a drop in the teacher production rate of approximately 12 percent between 1966 and 1972.*

We then examine a data base developed by the American Council on Education (ACE). In annual surveys of entering college freshmen, the ACE obtains data on their career plans and intentions. Since 1968, the rate at which entering college freshmen have indicated that they intend to pursue a teaching career has rapidly declined. *By 1972, the proportion of entering college freshmen who expected to enter the teaching profession had fallen to less than one-half of the proportions of entering college freshmen in 1968 who aspired to careers in elementary and secondary education.*

AN ANALYTICAL MODEL OF TEACHER PRODUCTION

We develop a theoretical model of occupational choice that identifies the influence of economic factors upon an individual's decision as to which career he or she will pursue. This model is used to derive a positive relationship (termed a supply function) between the number of individuals choosing a teaching career and the wage (monetary reward) for teaching, given the current eligible population, the distribution of tastes among that population, the wages in other occupations, and the respective nonmonetary rewards of teaching and all other occupations. We then extend the analysis to account for *shifts* in that supply function due primarily to population changes and introduce different expectation formulation hypotheses to establish the linkage between current labor market conditions and current individual career choice based on anticipated relative career returns. Finally, we use our economic career choice model to derive an explicit model of teacher production rates.

We estimate the career choice model cross-sectionally, using currently available data on teacher production rates by state, for three categories of eligible new graduates--females prepared to teach at the elementary level, females prepared to teach at the secondary level, and males prepared to teach at the secondary level.*

Considering, first, our results for males and females prepared to teach at the secondary level, we find that credentialing requirements and the relative size of the state's labor market for high-level (college-educated) manpower are not related to the proportions of graduates eligible to teach. Ruralization is positively related to the production of new teachers. The structure of a state's higher educational system is also related, in the expected way, to teacher production. The measures of teachers' relative wages are positively related to teacher production, and tend to be much more important in the estimates for the production of female teachers. The same is true for a set of variables used to measure expected employment security.

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*We did not attempt to estimate the model for males prepared to teach at the elementary level because the proportion of male college graduates who fall in this category is so small that reliable statistical inference is dubious.

In general, our results for females prepared to teach at the elementary level agree with the above findings, although there are fewer significant relationships. To the extent that females considering elementary teaching are responsive to relative labor market conditions, our results suggest that they are more sensitive to relative income levels than to employment opportunities.

A particularly important set of results concerns the lag structure of teacher production--the length of the delay between the time of selecting a teacher preparatory program and the time of entry into the pool of eligible new graduates. Our results suggest that a lag of three to four years is present in the long-run supply of teachers.

In summary, although the strength and consistency of our results vary considerably among the three types of eligible new graduates examined, there are *significant relationships between the number of new BAs qualified to teach and the relative teacher wage and relative teaching employment opportunities that prevailed three to four years earlier*. Hence, conditions in the market for teachers do influence college students' decision as to whether or not they will enter a teacher preparation program and thus affect the supply of teachers. In particular, the current surplus can be expected to adversely affect the rate at which future groups of eligible new graduates are prepared to teach.

PROJECTING THE SUPPLY OF TEACHERS

In view of the results of our reexamination of the NEA and the ACE data and our analysis of career choice, it is clear that the annual teacher production rate, which has consistently declined over the past seven years, is likely to continue do decline. To explore the possible implications of continued decline in the proportion of new college graduates who are qualified to teach, we project teacher production rates through 1981 under a variety of alternative assumptions. These rates are then multiplied by the NCES projections of annual numbers of new college graduates to illustrate the impact of the assumptions in terms of the annual supplies of new teachers. When we compare the annual supplies of new teachers that would be forthcoming

--if the production rate were to remain stable at 35 percent of the BA class--to the annual supplies implied by a declining production rate, we conclude that the previous studies have grossly overprojected the likely future supplies of new teachers. Consequently, their projections of the total supplies of teachers and of the sizes of the teacher surplus are overestimated. Further, our results suggest that *the rate of decline in the annual teacher production rates is likely to be significantly larger than the rate of growth in the annual numbers of new college graduates. Thus there is good reason to expect that the annual supplies of new teachers will decline sharply throughout the 1970s.*

The results outlined above also suggest that the previous studies have overestimated the annual supplies from the reserve pool, since an overprojection of the number of new teachers produced in any year results in an overprojection of the size of the reserve pool in subsequent years. To obtain an indication of how serious might be the implications of these overprojections, we projected the supply of reserve teachers through 1981 using a number of different sets of assumptions. The magnitude of the overprojection of the reserve supply that stems from overprojection of annual new teacher production varies from one set of projections to another, depending upon the assumptions used to develop the projections. But, in virtually every case, the impact is large.

To place these results in perspective we examine how the anticipated declines in teacher production rates might influence the teacher surplus, again resorting to the device of developing projections under alternative assumptions. *It is clear that regardless of what other assumptions are made, if the anticipated declines in teacher production rates materialize, the magnitude of the teacher surplus will be greatly affected.*

The limitations of the available data preclude projection of the likely future size of the teacher surplus with any reasonable degree of accuracy. Even if the teacher production rate should continue to decline throughout the 1970s, the surplus may persist. But we can be reasonably sure that the surplus will not grow in 1980 as has been suggested by the previous studies. In fact, assumptions consistent with the available evidence regarding the supply of teachers yield a set of projections that foresee the end to the surplus in 1980.

The major implication of the analysis is that *policymakers concerned with the educational personnel system cannot simply assume that the surplus is here to stay in formulating their long-term plans.* This point becomes particularly important when the lag structure of the system is taken into account. The current level of teacher production depends upon the career choices made by college freshmen and sophomores three or four years ago. Even if the surplus were to end in 1980, we could expect annual rates of teacher production to continue to decline for two to four years thereafter. In essence, teacher production will not begin to grow until students who enter college after the end of the surplus begin to graduate.

The reserve pool has even more inertia. Its size in any year, given the demand for teachers, depends upon the career choices made by college students approximately 30 years previously. And its size will grow only if teacher production grows more rapidly than does the sum of net demand and annual exits from the system. Some idea of the lead time involved is given by one set of projections in which we assume that teacher production declined throughout the 1973-1981 period. Yet the annual reserve supply continued to grow until 1980. Just as the reserve supply can grow for a number of years after teacher production levels begin to decline, once that supply begins to drop we can expect it to continue to fall for some years after teacher production begins to rise. *Thus there appears to be a real possibility that the system will "overrespond" to the surplus.*

CONTENTS

PREFACE iii

SUMMARY v

Section
I. INTRODUCTION 1
  Objective 1
  The Problem 1
  The Plan of This Report 5

II. THE CONCEPT OF TEACHER SUPPLY 7
  Overview of the System 7
  Components of Supply 10
  A Descriptive Model of the Supply of Teachers 12
    Notation 12
    The Supply of Teachers 14
  Projecting the Supply of Teachers 16
    Initial Stocks 17
    High School Graduating Classes 18
    Annual Demands for Teachers 18
    Parameters of the Model 19

III. TEACHER SUPPLY PARAMETERS 20
  Previous Studies of Teacher Supply 20
    The National Education Association 20
    The Commission on Human Resources and Advanced Education . 21
    The Department of Labor 21
    The National Center for Educational Statistics 22
    The Rattner Study 23
    The Froomkin Study 24
  Projecting the Supply Parameters 24
    College Entry and College Completion 25
    Exits from the System 26
    School District Choice 28
    Career Choice 29
  Teacher Production Rates 33
    Currently Available Estimates 33
    Career Choices of Entering College Freshmen 37

IV. AN ANALYTICAL MODEL OF TEACHER PRODUCTION 42
  Overview 42
  An Economic Model of Occupational Choice 43
  A Caveat on Risk and Unemployment 50
  A Model of Teacher Production: The Long-Run Supply Response 51

Alternative Models for Devising Occupational Returns Expectations 52
Determinants of the Number of Eligible New Graduates 54
Model Modification for Cross-Sectional Analysis across States 55
Summary 58

V. EMPIRICAL TEST OF TEACHER PRODUCTION MODEL 60
Direct and Proxy Variables 60
Empirical Results from Cross-Section Models 65
Importance of Economic Variables 69
Results for Females Eligible To Teach Secondary Grades 70
Results for Males Eligible To Teach Secondary Grades 73
Results for Females Eligible To Teach Elementary Grades 76
Length of Lag 76
Results for Females Eligible To Teach Secondary Grades 78
Results for Males Eligible To Teach Secondary Grades 78
Predictive Ability 79
Results for Females Eligible To Teach Secondary Grades 79
Results for Males Eligible To Teach Secondary Grades 83
Summary 84

VI. CONCLUSIONS AND IMPLICATIONS 85
The Teacher Production Rate 85
The Supply of New Teachers 86
Alternative Projections 86
Discussion of the Projections 90
The Supply of Reserve Teachers 91
Alternative Projections of the Reserve Supply 92
Discussion of the Projections 97
The Teacher Surplus 99
The Continuing Supply of Teachers 100
Alternative Projections 100
The Results 101
Long-Term Implications 102

Appendix

A. PROJECTIONS OF THE DEMAND FOR TEACHERS 105
B. DATA AVAILABILITY AND DATA GAPS 111

REFERENCES 121

I. INTRODUCTION

OBJECTIVE

The teacher surplus that emerged during the late 1960s confronted the educational community with the need to develop new personnel policies. This need arose in part because previously developed policies focus on the shortage situation and are not appropriate in general surplus conditions. Moreover, the information available to policymakers concerned with the educational personnel system is inaccurate and unreliable, particularly in regard to the supply of educational personnel. In fact, there appears to be considerable confusion as to what is meant by the concept of manpower supply aside from the problems of estimating the likely future supply of teachers. The objective of this study is to contribute to the development of appropriate responses to the teacher surplus through a detailed theoretical and empirical analysis of the long-run supply of teachers.

THE PROBLEM

During the two decades following World War II, there were national shortages of teachers in almost all fields. Accordingly, educational manpower policy was dominated by a concern with meeting critical shortages of educational professionals. The educational manpower situation changed dramatically with the emergence of a national teacher surplus in the late 1960s. After more than 20 years of expanded teacher training programs, schools of education were unable to place some of their graduates. Several recent projections of the market for teachers forecast persistent surpluses into the 1980s. If these projections are accurate the educational personnel preparation system--those segments of the educational community concerned with teacher training--will have to adjust to meet the new situation.

Some segments of the system have already responded to the expectation of a continuing excess of teachers. Several major colleges and universities have limited admissions to their schools of education or have taken other steps to cut back teacher training.* Programs that had encouraged entry into teacher education have been abolished in at least three states.** Potentially the most important response to the teacher surplus is the substantial shift in the career intentions of college students. Annual surveys of entering college freshmen, conducted by the American Council on Education (ACE), show consistent declines since 1969 in the proportion who intend to pursue a career in teaching.+

As yet, however, such responses are isolated. Van Dine (1972), for example, argues that schools of education have been accepting more students and producing more teachers every year. This lack of response to what appears to be an increasing problem is no doubt partly due to inertia. Schools of education, for example, have made commitments to faculty that would be difficult to honor if their programs are substantially decreased in size. Similarly, commitments to students "in the pipeline" preclude immediate reductions in teacher training programs other than at the entry point. There is also a moral issue. Does an institution of higher education have the right to deny a student the access to an education of his or her choice?

Irrespective of these considerations, a third factor that seriously inhibits the development of policy responses to the teacher surplus is uncertainty. Given the lags in the system (e.g., approximately four years between college entry and completion, the time required to build up or reduce faculty levels in schools of education), it is clear that decisions being made now will have little immediate effect on the teacher surplus, but rather will have an impact on the size and the characteristics of the stock of educational professionals some years in the future. This, in turn, means that decisions must be based upon an estimate of the likely future state of the market for educational professionals. There are serious questions as to the accuracy and reliability of the currently available analyses of the market for teachers.

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*See, for example, Maeroff (1972) or Miller (1972).

**For a more detailed discussion, see Van Dine (1972).

+The ACE results are discussed below. See Section III.

Table 1 provides the estimates of the teacher surplus reported by the National Education Association (NEA) (1972), the National Center for Educational Statistics (NCES) of the U.S. Office of Education (1971), Joseph Froomkin and Associates (1971), Edward Rattner and Associates (1971), the U.S. Department of Labor (DOL) (1972), and the Commission on Human Resources and Advanced Education (1970).* One study projects a surplus of 62,000 teachers in 1975 while another estimates a teacher surplus as about 400,000 that year. A third study provides an estimate of the teacher surplus in 1980 equal to 73,000. According to a fourth study, the surplus of teachers in 1980 could reach 1,510,000. These variations become even less understandable when it is recognized that all four studies use essentially the same methodology--trend extrapolation--to obtain these results. It is no surprise that some educational policymakers have found it difficult to determine an appropriate response to the teacher surplus.

Examination of the studies reveals that there are few differences in their projections of the demand for teachers (see Table 2). There is complete agreement among the studies as to what they mean by the demand for teachers and substantial agreement as to the appropriate projection of demand.** The situation with respect to the supply of teachers is quite different. There is considerable disagreement among the six projections of the supply of teachers (see Table 3).

Two factors account for the wide variation among projections of teacher supply. First, there is little agreement among the studies as to what is meant by the concept of manpower supply. Consequently, there are considerable differences among the studies in terms of how each goes about projecting the supply of teachers. Second, there are many serious gaps in the available data concerning the supply of educational professionals. Many of the key parameters that underlie each of the supply

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*Neither the DOL nor the Commission explicitly projects the teacher surplus. Both project the demand for teachers through 1980 and compare their respective projections with trends in the supply of teachers. We have imputed the surplus projections implicit in their discussion. The Commission's results are reported in Folger, Astin, and Bayer (1970).

**See Appendix A for details of the various projections of the demand for teachers and an assessment of their reliability.

Table 1

EXCESS TEACHER SUPPLY PROJECTIONS: 1972, 1975, 1980 (in thousands)

Projection	1972	1975	1980
NEA	118	--	--
Commission[a]	31	62	122
DOL[a]	10	54[b]	73
NCES	135	185	191
Rattner	0[c]	--	1,510/930[d]
Froomkin	-198[c]	414	619

[a] Surplus estimated by imputing supply projection and subtracting projected demands.

[b] Estimate for 1976.

[c] Estimate for 1970.

[d] High/low estimates.

Table 2

ESTIMATED DEMAND FOR TEACHERS: 1972, 1975, 1980 (in thousands)

Projection	Total Demand			Demand for New Hires		
	1972	1975	1980	1972	1975	1980
NEA	2,112	--	--	197	--	--
Commission	--	--	--	207	211	180
DOL	2,326	2,311[a]	2,349	180	177[a]	200
NCES	2,295	2,305	2,316	180	162	200
Rattner	2,269[b]	2,304	2,354	--	--	--
Froomkin	2,531[b]	2,611	2,927	--	--	--

[a] Estimate for 1976.

[b] Estimate for 1970.

Table 3

ESTIMATED SUPPLY OF TEACHERS: 1972, 1975, 1980
(in thousands)

Projection	Total Supply			New Supply		
	1972	1975	1980	1972	1975	1980
NEA	2,230	--	--	315	--	--
Commission[a]	--	--	--	238	273	302
DOL[a]	--	--	--	190	231[b]	273
NCES	--	--	--	315	347	391
Rattner	2,269[c]	--	3,864/3,284[d]	--	--	--
Froomkin	2,333[c]	3,025	3,546	--	--	--

[a] Imputed.

[b] Estimate for 1976.

[c] Estimate for 1970.

[d] High/low estimates.

projections are estimated. Variations among studies in the estimates of these key parameters thus account for part of the differences in their projections.

In summary, the emerging teacher surplus has created a number of important policy issues. The ability of the educational community to respond to these issues has been seriously constrained by the abundance of conflicting estimates and the lack of adequate data regarding the likely future dimensions of the problem. The plethora of notions as to what is meant by the supply of educational personnel further complicates matters by creating serious communications problems.

THE PLAN OF THIS REPORT

This report addresses four main topics: the concept of manpower supply as it applies to the educational personnel system, the available estimates of the key parameters that underlie the supply of teachers, the factors that influence teacher production (the rate at which eligible new graduates are prepared to teach), and the likely future trends in the supply of teachers. We begin, in Section II, with an overview of the educational manpower system, focusing on the basic manpower pools from which a local educational agency can recruit professional staff. A descriptive model of teacher supply is then developed and used to identify the parameters that underlie teacher supply. In Section III, we review the major studies of the market for teachers and examine the methods each used to estimate the values of the underlying parameters. We also review the available evidence regarding the most important parameter--the teacher production rate. Section IV is devoted to the development of a theoretical model of occupational choice that is amenable to empirical analysis given the available data. The model is estimated using data from a variety of sources. The results of this analysis are presented in Section V. We examine the likely future trends in the supply of teachers and present our major conclusions in Section VI.

II. THE CONCEPT OF TEACHER SUPPLY

OVERVIEW OF THE SYSTEM

The system for the preparation and utilization of educational professionals is a complex, highly interlinked network comprising some 1,200 higher educational institutions, 16,000 local school systems, 50 state educational agencies, several federal agencies, and a number of other private and public organizations. Individuals are attracted to, trained for, enter, and reenter the teaching profession along many different paths. It is useful to begin by describing the system as a whole.

Figure 1 provides a framework for our analysis of the supply of educational personnel. The flow of persons into the teaching profession begins with students graduating from high school. Some go on to college; the remainder engage in some other activity--working in some other occupation (including homemaking), joining the Armed Forces, and so on. Many persons who enter college upon graduation from high school drop out prior to achieving their BA degree (represented by the flow of persons from college to other activities). At the same time, many persons enter, or reenter, college some time after leaving high school, thus generating a flow of persons from other activities to college.

The next important element of the model consists of the flow of bachelor's degree recipients out of college. We divide this flow into three components. The first includes those persons who are qualified to teach; that is, persons who have completed an approved program or accumulated the requisite amount and distribution of college courses for initial certification.* The second major component of the flow of college graduates includes persons who are not qualified to teach upon

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*In 1970, four states--Nebraska, South Dakota, Wisconsin, and Vermont--did not require a bachelor's degree for beginning elementary teachers. But three of these (excepting Vermont) have officially set deadlines for enforcement of the degree. All states require at least the bachelor's degree for beginning secondary school teachers. Thus it is not unduly restrictive to limit discussion of persons qualified to teach to those who have completed college.

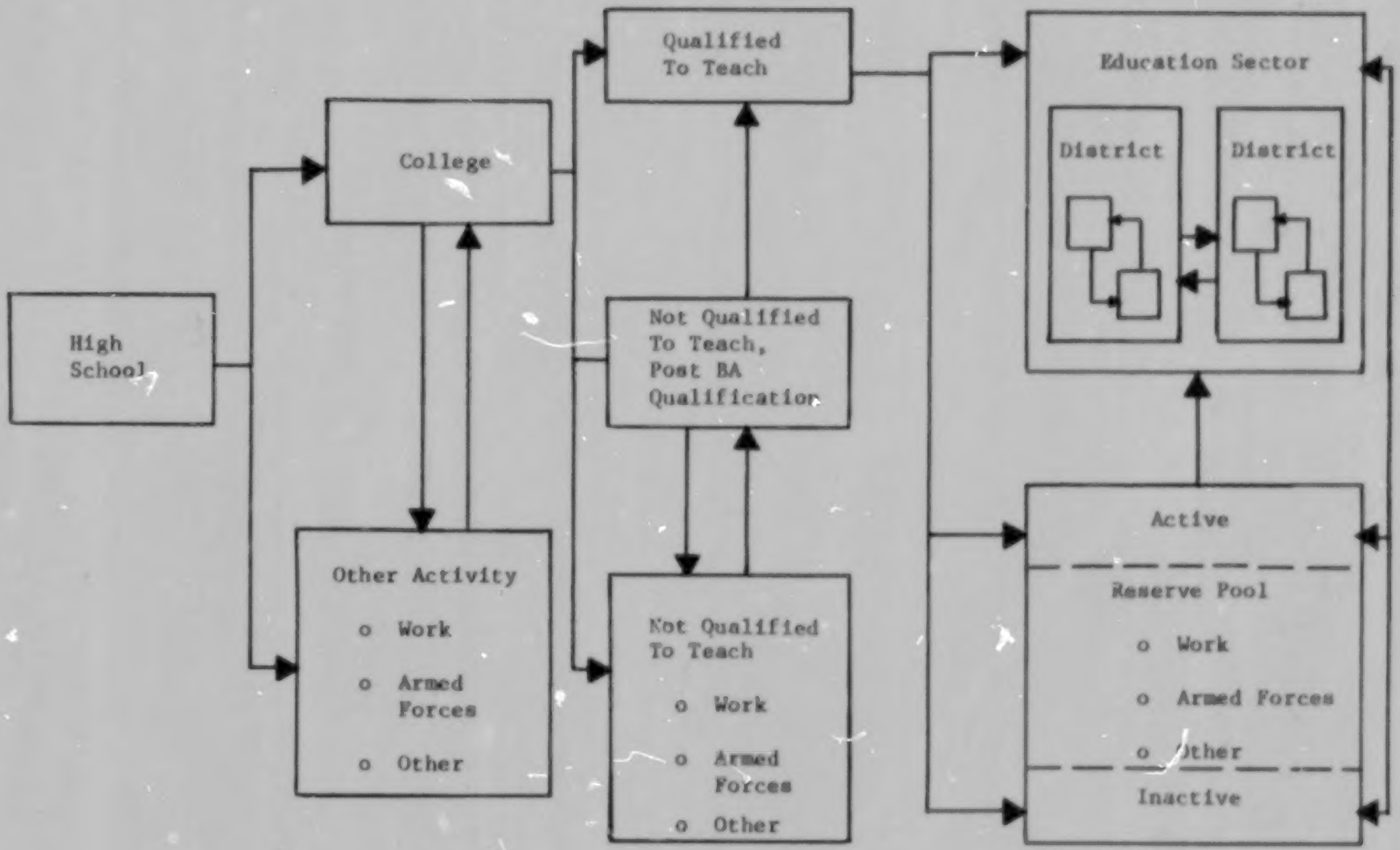
High School
College
Other Activity
o Work
o Armed Forces
o Other
Qualified To Teach
Not Qualified To Teach, Post BA Qualification
Not Qualified To Teach
o Work
o Armed Forces
o Other
Education Sector
District
District
Active
Reserve Pool
o Work
o Armed Forces
o Other
Inactive

Fig. 1--Flow Diagram of the Supply of Educational Personnel

graduation but who enter a post BA program that leads to qualification. This may be a year of graduate education or, perhaps, a sequence of undergraduate courses, depending upon state requirements. Such persons eventually flow to either the pool of persons qualified to teach or the pool of persons not qualified to teach, depending upon whether or not they successfully complete the program. The third component of the flow of college graduates includes BA degree recipients not qualified to teach who engage in some activity other than a post BA qualification program. Some may subsequently enter some post BA qualification program[*] and, if they complete the program, join the ranks of persons qualified to teach.

The third important element of the model consists of the flow of persons qualified to teach. They flow directly into teaching or into the reserve pool. The reserve pool includes all those persons who are qualified to teach but are not currently teaching. Since the currently employed teachers in the education sector and the reserve pool of teachers comprise the total stock of teachers at any time, the flow of persons qualified to teach is a critical element in the educational manpower system. For, as the diagram indicates, this flow of persons is the only means for *increasing* the total stock of teachers.

The fourth important element of the model consists of the flows between the reserve pool and the education sector. Individuals in the reserve pool who seek and find a teaching position move into the education sector. At the same time, persons employed as teachers leave the profession for a variety of reasons, thus entering the reserve pool.

Finally, there are a series of flows (not shown) out of the system, representing permanent exits from the system due to death, disability, or retirement. We should note that only retirement at an advanced age is viewed as a permanent exit from the system. Many young persons "retire" from the educational profession in the sense that they leave a teaching position and engage in some other activity (e.g., homemaking) with no intention to ever reentering the profession. However, as long as they are capable of reentering the profession at some future date, we would view them as part of the reserve pool.

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[*] A graduate program or a sequence of undergraduate courses, depending upon state certification requirements.

COMPONENTS OF SUPPLY

As shown in Fig. 1, there are three basic manpower pools from which a local education agency (LEA) can recruit professional staff. The first is the stock of personnel employed in the educational system. Each year LEAs fill the vast majority of professional positions with continuing personnel derived from the pool of individuals who filled professional positions the previous year. The other two sources from which professional personnel are recruited are the pool of initially qualified new college graduates (including advanced degree recipients)[*] and the reserve pool. Each of these manpower pools generates a supply of professional personnel. The total teacher supply therefore consists of three distinct elements: the continuing supply, the supply of beginning teachers, and the supply of reentering teachers.

The supply of educational personnel derived from a supporting manpower pool consists of those persons from the pool seeking professional positions. The continuing supply of educational professionals thus consists of those persons employed in professional positions in education who remain in the system. Professionals who retain their positions or who shift from one teaching position to another are included in the continuing supply because they obviously remain available for employment in the system. Professionals who leave one position in the system and seek another,[**] or who leave the profession and do not attempt to reenter are viewed as entering the reserve pool.

The component of the supply of educational professionals that has received the most attention in previous analyses of the market for educational professionals is the supply of beginning teachers, derived from the pool of initially qualified new graduates. The NEA reports that annually, between 1954 and 1968, roughly 80 percent of teacher education graduates[*] at the elementary level and 70 percent of teacher education graduates at the secondary level enter classrooms upon graduation. Since there were widespread teacher shortages throughout most of this period, it is clear that many newly qualified or eligible graduates voluntarily choose not to seek teaching positions. Again, the basic point is that the pool of initially qualified new graduates includes persons who seek teaching positions and either enter teaching or the reserve pool, depending upon their success in obtaining a position. But it also includes persons who make no attempt, for whatever reasons, to enter the profession. The supply of beginning teachers properly includes the former group, but not the latter.

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[*] Our use of the term "new graduates" to describe initially qualified personnel is purely a matter of convenience. Most educational professionals receive their training in a college degree program and are qualified upon graduation; however, persons who become qualified at some later time are also included.

[**] The classic example is the teacher who leaves a position in one locality, moves to another area of the country, and seeks a position in the new location.

As shown in Fig. 1, we divide the reserve pool into two parts. The active segment of the reserve pool includes persons qualified to teach who are actively interested in teaching in the sense that they would accept a teaching job if one were offered to them. The inactive segment of the reserve pool includes persons qualified to teach but not actively interested in teaching. These persons may have sought a teaching position at some time in the past; they may seek a teaching position some time in the future. The important point is that these persons would refuse an offered teaching job. In other words, the supply of teachers derived from the reserve pool consists of the active segment of that supporting manpower pool.

The distinction between the supporting manpower pool and the supply of professionals derived from the pool is crucial in an analysis of the market for teachers. Each of the three pools defined above consists of individuals who are qualified to teach and thus are potentially available for employment as educational professionals. However, many of the individuals included in each pool voluntarily choose not to participate in the market for teachers. From the perspective of the educational personnel system, they are not candidates for teaching positions.

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[*] The NEA uses the term "teacher education graduates" to describe all college graduates at either the BA or MA degree level who are qualified to teach upon graduation.

An immediate implication of these observations is that the size of the active reserve pool is the only valid measure of the teacher surplus. It is only these persons who are excluded from the profession by the lack of available jobs. Persons in the inactive reserve pool are qualified to teach; but, by definition, they would not accept a teaching position even if one were offered to them. Hence, their absence from the profession has nothing to do with the current availability of job opportunities in education.

A DESCRIPTIVE MODEL OF THE SUPPLY OF TEACHERS

The conceptual framework of Fig. 1 contains an implicit flow model of the supply of teachers. The model is outlined in greater detail in the remainder of this section.

Notation

Most of the flows indicated in Fig. 1 occur at various times over the course of the school year. In order to avoid notational complexities, we assume that all flows of a given type take place at a single point in time. That is, all eligible new graduates are assumed to graduate at one time; all teachers who terminate are assumed to leave their positions at one time; and so on. Specifically, we assume that, at the beginning of year t, the reserve pool contains R_t persons, and the pool of eligible new graduates is empty. C_t teaching positions are filled by continuing teachers--persons employed in the education sector in the previous period who retain positions in the sector in year t. The first event in year t is college graduation, at which time those qualified to teach enter the pool of eligible new graduates. School districts, having determined the total number of teachers they will attempt to employ in year t, begin to fill their vacancies by hiring those eligible new graduates and persons in the reserve pool who seek teaching positions. After all hiring has taken place, any eligible new graduates who have not obtained teaching positions enter the reserve pool (emptying the pool of eligible new graduates) and no further flows occur until the end of the year. At that time, teachers and persons in the reserve pool who permanently exit from the system (death, disability, retirement, and so on) leave, and those teachers who terminate for other reasons flow from the education sector into the reserve pool.

Let S_t = total supply of teachers in year t,

G_t = supply of eligible new graduates in year t,

A_t = supply of reserve teachers (active segment of the reserve pool in year t),

C_t = continuing supply of teachers in year t,

E_t = number of eligible new graduates in year t,

R_t = number of the reserve teachers in year t,

T_t = number of persons employed as teachers in year t,

N_t = number of college entrants in year t,

H_t = number of high school graduates in year t,

B_t = number of college graduates in year t,

D_t = total number of teachers demanded in year t,

α_t = proportion of eligible new graduates seeking teaching positions,

γ_t = proportion of persons in the reserve pool seeking teaching positions,

δ_t = rate at which teachers permanently exit from the education sector,

ε_t = rate at which teachers flow from the education sector into the reserve pool,

$\theta_{t,n}$ = proportion of high school graduates in year n entering college in year t,

$\xi_{t,n}$ = proportion of college entrants in year n graduating from college in year t,

ϕ_t = proportion of college graduates qualified to teach,

π_t = rate at which reserve teachers seeking positions find them,

ψ_t = rate at which eligible new graduates seeking positions find them, and

ρ_t = proportion of reserve teachers who permanently exit from the system.

In general, we use a letter of the alphabet to denote a stock; that is, the number of persons in a particular situation in year t. We use a Greek letter to denote a flow, the rate at which persons move from one situation to another during year t.

The Supply of Teachers

The total supply of teachers in year t contains three components; the supply of eligible new graduates, the active segment of the reserve pool, and the supply of continuing teachers. That is,

$$S_t = G_t + A_t + C_t \ . \qquad (1)$$

The supply of eligible new graduates consists of those persons in the pool of eligible new graduates who seek teaching positions. Since α_t is the proportion of persons in that pool who seek positions in the education sector in year t, we can write

$$G_t = \alpha_t \, E_t \ . \qquad (2)$$

Similarly,

$$A_t = \gamma_t \, R_t \ , \qquad (3)$$

and

$$C_t = (1-\delta_{t-1})(1-\epsilon_{t-1})T_{t-1} \ . \qquad (4)$$

The pool of eligible new graduates in year t can be described by a set of three equations. The first expresses the number of college entrants in year t as a sum of the numbers of persons who graduated from high school n years earlier for all relevant values of n. The second expresses the number of college graduates in year t as a sum of the numbers of persons who entered college n years earlier, again for all relevant values of n. And the third relates the number of new graduates in year t eligible to teach to the number of graduates that year. Thus,

$$N_t = \sum_n \beta_{t,n} H_n \; , \qquad (5)$$

$$B_t = \sum_n \xi_{t,n} N_n \; , \qquad (6)$$

$$E_t = \phi_t B_t \; . \qquad (7)$$

Turning to the variety of flows into and out of the reserve pool, suppose that the size of the reserve pool at the beginning of year t-1 is R_{t-1}. Since γ_{t-1} is the proportion that sought teaching positions, and π_{t-1} is the proportion of those who found a position, then $\pi_{t-1}\gamma_{t-1}R_{t-1}$ persons flow from the reserve pool into the education sector and the remainder, $(1-\pi_{t-1}\gamma_{t-1})R_{t-1}$, stay in the pool. The flow from the education sector into the reserve pool is $\epsilon_{t-1}T_{t-1}$. Finally, since ψ_{t-1} is the rate at which the eligible new graduates who seek teaching positions are successful, then the flow of eligible new graduates into the reserve pool is $(1-\psi_{t-1}\alpha_{t-1})E_{t-1}$, where α_{t-1} is the proportion of year t-1 eligible new graduates who seek teaching positions. Thus,

$$R_t = [(1-\pi_{t-1}\gamma_{t-1})R_{t-1}+(1-\psi_{t-1}\alpha_{t-1})E_{t-1}+\epsilon_{t-1}T_{t-1}](1-\rho_{t-1}) \; . \qquad (8)$$

Finally, the number of qualified persons employed as teachers in year t depends upon the condition of the market for teachers in that year. If there is an excess supply of teachers, districts will be able to satisfy their demands fully and $T_t = D_t$. If, on the other hand, there is a shortage of teachers in year t, districts will be able to hire only the number of teachers available to them (making up the shortfall through extensive use of substitute and part-time teachers and underqualified personnel and increased class sizes). Then $T_t = S_t$. In sum,

$$T_t = \mathrm{Min}\,(D_t, S_t) \; . \qquad (9)$$

One implication of the above comments is that the size of the teacher surplus in year t equals $S_t - D_t$. (A negative value indicates a "negative" surplus, that is, a shortage.) If, in year t, S_t exceeds D_t, the size of the surplus can also be written as follows:

$$S_t - D_t = (1-\pi_t)A_t + (1-\psi_t)G_t \ .$$

The model embodied in Eqs. 1-9 is descriptive in the sense that it portrays the relationships among the various quantities of interest. The parameters of the model--indicated by Greek letters--are behavioral in that they reflect the actions taken by individuals. But the model does not indicate how the values of those parameters are determined. For example, ϕ_t is defined as the proportion of eligible new graduates who seek teaching positions. There are a number of factors (e.g., teacher salary levels, salary levels in alternative occupations, the availability of teaching positions, and so on) that may influence each eligible new graduate's decision as to whether or not to seek a teaching position. None of these factors is included in the model. The point is that the model identifies the parameters that underlie the supply of teachers and provides a mechanism for identifying the consequences (in terms of teacher supply) of individuals' behavior.

PROJECTING THE SUPPLY OF TEACHERS

Four kinds of data are required to project the supply of teachers. First, the current sizes of each of the three supporting pools must be established. These data provide a set of "starting" conditions. Second, we must estimate the sizes of the annual high school graduating classes. These estimates provide the basis for projecting the annual influx into the system (Eqs. 5, 6, and 7). Third, we require estimates of the annual demands for teachers. These permit the calculation of the sizes of annual surpluses or shortages and enter the determination of the annual supplies of continuing teachers and the sizes of the reserve pool each year. And, fourth, we require estimates of what will be the values of each of the parameters of the model for each of the years in the projection period. These, in conjunction with the first two sets of data, permit the projection of the flows into, within, and out of, the educational personnel system.

Initial Stocks

Obtaining the first set of data presents no conceptual problems. What are needed are essentially counts of the current numbers of persons in each of the three supporting manpower pools. There are, however, some serious data acquisition problems. The parameters of the model reflect the aggregate behavior of groups of heterogeneous individuals. We have, for example, assumed that teachers flow from the education sector to the reserve pool at rate ε_t in year t. There is abundant evidence that the probability of termination varies from one teacher to another depending upon the teacher characteristics (e.g., age, sex, family situation, and so on).[*] This means that even if teachers of a given "type" (having the same characteristics) terminate at the same rate over time, the aggregate teacher termination rate will vary with the composition of the teacher force. Similarly, women have traditionally prepared to teach at significantly greater rates than have men. Thus, α_t, the proportion of year t college graduates qualified to teach, will vary from year to year with the sex composition of the class of BA graduates, even if the men and women in each annual class prepare to teach at constant respective rates.

In general, when there are significant differences among different types of individuals in terms of their behavior, we have to treat the flows of individuals of each type separately, and then aggregate. Equation 2, for example, might be rewritten as follows:

$$G_t = \sum_i G_{it} = \sum_i \alpha_{it} E_{it} ,$$

where E_{it} is the number of year t eligible new graduates of type i and α_{it} is the proportion of type i eligible new graduates who seek teaching positions in year t. Alternatively, we can use Eq. 2 in its current form ($G_t = \alpha_t E_t$) with α_t defined as the weighted average proportion of eligible new graduates seeking positions; that is,

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[*] See Emmett Keeler (1973) and the references cited therein.

$$\alpha_t = \frac{\sum_i \alpha_{it} E_{it}}{\sum_i E_{it}} .$$

Clearly, in either case, we need data on the *composition* of the pool of eligible new graduates and not simply the number of persons in that pool. The same remarks apply to each of the other two supporting manpower pools.

High School Graduating Classes

The second set of data--estimates of the annual size and composition of the high school graduating classes--presents somewhat greater difficulties because, for projections extending more than four years into the future, we have to project the future high school graduating classes. However, for projections extending less than 18 years into the future, the size of each annual group of students is easily established, and the only problem is that of projecting each group's high school completion rate.*

Enrollment rates in elementary and secondary education are quite high. Further increases will thus have relatively small impacts on high school completion rates, and there is no reason to expect significant declines in these rates. Overall, it would seem that the annual sizes of high school graduating classes can be projected reasonably accurately with few conceptual problems.

Annual Demands for Teachers

Estimating the sizes of the annual demands for teachers is an extremely complex and difficult task. Appendix A describes the methodology generally used to project the demands for teachers and reviews the previous attempts at teacher demand projections. There are a number of limitations to the available studies, also discussed in Appendix A. However, since our primary concern is to analyze the supply of teachers, we will make no attempt at a more accurate demand analysis here.

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*Projections extending more than 18 years into the future require the projection of birth rates.

Parameters of the Model

We have noted that the model's parameters are behavioral in the sense that they reflect the aggregate responses of groups of individuals to external influences. This means that in order to estimate the values of the teacher supply parameters in, say, year t, we would have to identify the relationships between each parameter and the factors that influence it, project the values of those factors to year t, and then estimate the values of the parameters in year t, given the projected values of the influencing factors. The problem is further complicated by the need for disaggregated parameter estimates (that is, separate estimates of the value of each parameter for each type of person) where the influence of an underlying factor varies from one type of person to another. We shall discuss the difficulties encountered in performing this task at greater length below.

III. TEACHER SUPPLY PARAMETERS

The principal difficulty encountered in projecting the supply of teachers is estimating the likely future magnitudes of the rates of flow into, within, and out of the educational personnel system. In this section we examine the available evidence regarding these teacher supply parameters. We begin with a detailed review of previous analyses of teacher supply. Next, we consider the reliability of the various techniques used in the studies to estimate the parameters. Finally, we examine the recent trends in the critical supply parameter--the proportion of new graduates qualified to teach.

PREVIOUS STUDIES OF TEACHER SUPPLY

The National Education Association

The NEA provides an annual assessment of the current state of the market, but makes no attempt to project its likely future state. They obtain estimates, through an annual survey of colleges and universities, of the number of degree recipients, at both the BA and the MA levels, who will be qualified to teach upon graduation. In 1972, for example, the NEA reported that about 310,000 graduates were qualified to teach. They assume that past trends in the proportion of eligible new graduates who seek teaching positions will continue. Specifically, they assume that 83.3 percent of graduates prepared to teach in elementary grades and 69.2 percent of graduates prepared to teach secondary grades would be available for employment if positions were offered. The supply of eligible new graduates is thus estimated to have been about 232,000 in 1972.

The reserve supply in 1972 was estimated by the NEA to have been about 83,000 persons. This estimate was based on a survey of the U.S. Bureau of the Census, conducted in 1960, which estimated that the pool of unemployed elementary and secondary teachers contained about 304,000 persons. Assuming that this pool contains the 20-year accumulation of 1.5 percent of the teachers employed each year, the NEA estimates the reserve pool to contain just under 456,000 persons in 1972. The NEA assumes an annual reentry rate of 18.3 percent, based on the fact that about 56,000 reserve teachers reentered teaching positions in 1960.

The Commission on Human Resources and Advanced Education

The Commission did not explicitly project the supply of teachers. It did, however, project the annual numbers of BAs and MAs in education and compared their estimates of the annual net demand for teachers with the availability of new graduates having degrees in education. Thus the Commission implicitly used the projected numbers of education degrees as their measure of the annual supplies of new teachers. These are the estimates provided in Table 3.

The Commission's projection method was essentially identical to Eqs. 5, 6, and 7 in the descriptive model, except that their definition of eligible new graduates was limited to those whose degrees were in education rather than those who were qualified to teach upon graduation. Note that the Commission defines the supply of eligible new graduates as the number of new college graduates eligible to teach, despite the significant proportion (approximately 28 percent overall) of that group that traditionally has not attempted to enter teaching positions.

The Commission cites U.S. Office of Education surveys conducted in 1958 and 1960, which estimated that 27 and 34 percent, respectively, of all newly hired teachers were reentering teachers. They did not, however, attempt to estimate the reserve supply.

The Department of Labor

The DOL did not attempt to project the supply of teachers. Rather, they examined the historical absorption of BAs into teaching. There are "excess" teachers, in their view, if the projected proportion of new BAs needed in teaching is less than the historical percentage absorbed. Note that if Eq. 7 in the descriptive model is substituted for Eq. 2, we obtain the number of new graduates qualified to teach who seek teaching positions as a proportion ($\alpha_t \cdot \phi_t$) of new graduates. Since relatively few qualified teachers seeking positions during the teacher shortage would not be able to enter the profession, the number of qualified new graduates who seek positions in teaching would approximately equal the number of qualified new graduates absorbed into teaching during this period. Since DOL used data predating the surplus, we can accordingly view their analysis as an application of Eqs. 2, 5, 6, and 7 of the model.

As the DOL did not explicitly project the supply of teachers, we imputed projections using the model implicit in their analysis. They argue that about 21 percent of new BAs were absorbed into teaching in 1970. Assuming that the size of the surplus in 1970 was approximately zero, .21 is an estimate of $\alpha_t \cdot \phi_t$.* We thus multiplied the DOL estimates of the annual numbers of college graduates by .21 to obtain the estimates given in Table 3.

About 25 percent of new hires are reentering teachers, according to the DOL; but they also make no attempt to estimate the reserve supply.

The National Center for Educational Statistics

The NCES projects the annual supply of eligible graduates by a straightforward procedure. The annual size of the BA and first professional degree class is projected and multiplied by an estimate of the ratio of graduates qualified to teach to total BA and first professional degrees. The size of the BA and first professional degree class in any year is assumed to be proportionate to the number of 18-year-olds four years earlier where the proportion follows a time trend. The projected annual ratios of graduates qualified to teach to total graduates, obtained from the NEA, are generated by a trend extrapolation of past ratios. Thus the NCES approach is equivalent to using Eqs. 5, 6, and 7 of the descriptive model where the parameters in the equations are assumed to follow fixed trends over time.

The NCES notes that the reentry of former teachers amounts to about 3.5 percent of total teachers employed in the education sector;

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*Note that according to the NEA, α_t--the proportion of new graduates eligible to teach--is about .35, and ϕ_t--the proportion of eligible new graduates who seek teaching positions--is about .72.

but they explicitly define the supply of teachers as including only new college graduates eligible to teach. They also note that annually about 80 percent of new elementary teachers and 67 percent of new secondary teachers actually enter active teaching. The estimated annual supplies of new graduates is not, however, adjusted to reflect the difference between the pool of eligible new graduates and the supply which derives from it.

The Rattner Study

Rattner and his associates define total teacher supply in any year t as the sum of those graduates eligible to teach over the previous 30 years. Total teacher supply thus includes those currently teaching and those outside the teaching profession either in other occupations or wholly outside the labor market. The Rattner study also argues that the market for teachers was balanced (i.e., zero surplus) in 1970 and, in that year, the reserve pool of teachers was approximately 62 percent of the total number of persons employed as teachers. The study therefore assumes that the reserve supply is essentially equal to the number of persons in the reserve pool in excess of 62 percent of the number of teachers in the education sector.

The Rattner group uses the NCES trend projections of the annual numbers of college graduates. Two alternative estimates of the proportion of new graduates qualified to teach are used. One, .35, reflects current behavior, while the other, .25, represents a more conservative estimate. This conservative estimate was used because the projected change in the teacher manpower situation from shortage to surplus was expected to reduce the proportion of college graduates preparing to teach. The resulting supply estimate is quite sensitive to the size of the parameter assumed. Over the ten-year period from 1970 to 1980, the use of the conservative .25 rate reduced the total teacher supply estimate 580,000 below the estimate using .35.

The Froomkin Study

Froomkin's approach to the projection of the supply of teachers is based on the assumption that the age-specific entry and exit rates for teachers of each sex are constant over time. He projects college attendance rates, by sex and age, and applies them to projections of the U.S. population to obtain projections of the aggregate numbers of persons, by sex and age, who will have completed four or more years of college. Each estimate is then multiplied by an age-by-sex specific estimate of the labor force participation rate to obtain projections of the age-by-sex distributions of persons in the labor force having four or more years of college. Assuming that past age-by-sex entry rates into teaching are maintained, he projects the numbers of persons who will enter the profession in 1975 and in 1980. The age-by-sex distribution of teachers in 1970 is weighted by the assumed constant, age-sex-specific exit rates to obtain the distributions of retained teachers in 1975 and in 1980. Finally, new entrants and retained teachers are aggregated to generate estimates of the total supply of teachers.

In essence, Froomkin's model is a generalization of the DOL approach. Where DOL examines absorption into teaching of new college graduates, Froomkin examines the absorption into teaching of persons who have completed four or more years of college, by age and sex. Of course, Froomkin's approach includes the reserve supply, since his estimates take account of entry into teaching by persons other than new graduates.

PROJECTING THE SUPPLY PARAMETERS

Despite the various differences among the six previous studies of the supply of teachers, they all use basically the same technique to project the future values of the basic teacher supply parameters--trend extrapolation. The accuracy of their projections thus depends upon the extent to which past trends in the parameters are continued into the future. The stability of trends in the parameters, in turn, depends upon the extent to which the underlying factors continue to follow past trends.

College Entry and College Completion

Two of the parameters--the proportion of high school graduates who enter college (β) and the proportion of college entrants who graduate (ξ)--are used to compute the annual numbers of college graduates. The previous studies essentially combine the two parameters into a single estimate, the ratio of the number of college graduates in year t to the number of 18-year-olds four years earlier. The studies assume that this ratio grows at a constant rate over time. They project the number of college graduates in year t by extrapolating the ratio to year t and multiplying it by the number of 18-year-olds in year t-4.

In the past, these projections have been reasonably accurate. However, both the NCES and the Carnegie Commission on Higher Education (which uses essentially the same technique) have recently announced that college enrollments are falling short of the projected levels by approximately 10 to 15 percent.* There are many hypotheses as to why past trends have not continued (students are questioning the relevance of college; students are "stopping out"; draft pressure has been eliminated; and so on). However, likely future trends in enrollments are unclear. Moreover, the impact of this deviation from past enrollment trends on trends in the annual numbers of college graduates has not been fully explored. Nonetheless, it is clear that if past trends in enrollments at the undergraduate level do not continue, past trends in the ratio of year t BA degrees to year t-4 18-year-olds will not be continued, at least through 1976.**

In sum, there is good reason to suspect that the projections of the annual numbers of college graduates used in the previous studies have been overestimated. If so, their projections of the annual size of the pool of eligible new graduates and the annual supplies of eligible new graduates are also overestimated.[*] Further, new graduates eligible to teach either enter teaching positions or the reserve pool and, in a surplus situation, each new graduate who enters a teaching position precludes entry by a teacher from the reserve pool who otherwise would have moved from the reserve pool to the education sector. Thus the size of the annual increase in the reserve pool is overestimated by the same amount as is the pool of eligible new graduates. And, of course, the impact of annual overestimates of the amount of increase in the reserve pool cumulates over time.[**]

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*See Watkins (1973).

**The majority of students who will graduate by 1976 have already enrolled. But, if "stopping out" becomes a widespread phenomena, even the near-term projections of numbers of graduates are suspect.

A complete analysis of the factors that influence college entry and completion is beyond the scope of this study. Thus we cannot go beyond the general observation that projections based on previous trends in college attendance and graduation are suspect.

Exits from the System

The rates of permanent exit from the education sector (δ) or from the reserve pool (ρ) are clearly the least difficult supply parameters to treat. They reflect the aging process, death, disability, and so on. It is safe to assume that past trends in these factors will be continued into the future. Hence, the use of trend extrapolation would be appropriate in this case. However, none of the previous studies chose to employ the technique.

The NEA, the Commission, the DOL, and the NCES project the teacher turnover rate. But none distinguishes between teachers who permanently exit from the system and teachers who, upon leaving their positions, enter the reserve pool. And none of these four studies considers exits from the reserve pool.

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[*] If about 35 percent of the new graduates are qualified to teach and about 72 percent of those seek positions, a 10-percent overestimate of the number of college graduates results in a 3.5-percent overestimate of the size of the pool and a 2.5-percent overestimate of the supply of eligible new graduates.

[**] If the increment to the reserve pool is overestimated by, say, 10,000 persons per year (.035 times 300,000, which is roughly the NEA estimate of the size of the pool of eligible new graduates in 1972), after ten years the reserve pool will be overestimated by about 100,000.

Rattner assumes that teachers permanently exit from the system 30 years after graduation. Froomkin assumes that teachers permanently exit from the system at age 65. Neither attempts to project the effects of death or disability on the group of teachers before the assumed retirement age.

Rattner's approach may be accurate in the case of a permanent exit from the reserve pool despite the fact that teachers in the reserve pool between the ages of, roughly, 52 and 65 can conceivably reenter the education sector. The relevant concern in an analysis of the supply of teachers is the number of persons who are qualified to teach and seek teaching positions. The aggregate size of the reserve pool is of interest solely because persons in the inactive segment of the pool are potentially capable of shifting to the active segment (i.e., seek a teaching position). Thus attention must focus on the number of type i teachers in the reserve pool times the proportion of type i reserve teachers who seek positions in the education sector.

Now, if reserve teachers past the age of, say, 52 never seek teaching positions, it makes no difference whether reserve teachers between the ages of 62 and 65 are included or excluded in the estimation of the size of the reserve pool provided that, if they are included, their number is multiplied by a zero in calculating the size of the active segment of the pool. From this perspective, the Rattner estimate is equivalent to assuming that persons qualified to teach but past the age of 52 never seek teaching positions.

On the other hand, the Rattner estimate assumes that persons employed in teaching positions retire permanently at age 52, which is clearly not the case.

School District Choice

Two of the parameters of the model--the proportions of eligible new graduates and reserve teachers, respectively, who seek teaching positions and find employment in the education sector (π and γ respectively)--reflect the aggregate behavior of school districts in terms of their employment decisions. When there is a teacher shortage, virtually all qualified professionals seeking teaching positions will be able to enter the education sector. However, in a teacher surplus, some qualified teachers will be unable to obtain teaching positions. The question of which teachers seeking positions will be forced into the reserve pool depends upon the choices made by districts confronted with more applicants than they have vacant positions. The parameters are important to the extent that different types of teachers exhibit different patterns of behavior.

The size of the surplus in year t depends upon the demand for and supply of teachers in the year t. Thus the issue of which teachers enter the education sector in year t and which are forced into the reserve pool in that year has no impact on the size of the year t teacher surplus. But the size of the year t+1 surplus depends upon the year t+1 supply of teachers, which includes the reserve supply. Finally, if different types of teachers in the reserve pool seek positions at different rates (i.e., behave differently), the year t+1 reserve supply depends upon the composition of the reserve pool, which, in turn, depends upon which teachers entered the pool in year t.

Neither the NEA nor the NCES addresses this issue. The Commission and the DOL assume that roughly 25 percent of new hires will be reentering teachers. Rattner assumes that about 3 percent of the total number of teachers are reentering teachers. However, all three calculations are based on data predating the emergence of the teacher surplus and hence reflect the number of reserve teachers seeking positions and not the number who succeed in obtaining positions. Froomkin attempts to project the numbers of persons by age and sex who will obtain positions, but offers no explanation whatsoever for his projections.

In sum, we do not have any reasonable estimate of what the values of these parameters might be. For that matter, we do not know if the issue is important. If different types of teachers behave in roughly similar ways, the employment decisions of districts matter little in terms of projecting the supply (and the surplus) of teachers. If, on the other hand, there are large differences in the behavior of different types of teachers, this issue could be quite important.

Career Choice

The remaining four parameters of the model reflect the career choices of individuals. The proportion of college graduates qualified to teach (ϕ) depends upon the extent to which college students choose to prepare for a career in teaching. The proportion of eligible new graduates who seek teaching positions (β) depends upon their decisions as to whether they will pursue a career in teaching or in some other occupation. Similarly, the proportion of teachers employed in the education sector who leave their positions and move to the reserve pool (ε) and the proportion of reserve teachers who seek teaching positions (γ) depend upon individual's decisions as to whether they will continue in their current careers or enter alternative careers.[*]

It is clear that these are the crucial parameters in an analysis of the supply of teachers. Given the number of college graduates in any particular year, the first parameter determines the size of the pool of eligible new graduates in that year. And because the pool of eligible new graduates is the source of personnel for the remaining two supporting manpower pools, the annual proportions of new college graduates eligible to teach, together with the annual sizes of the BA degree class, determine the sizes of all three pools over the long term. Finally, given the sizes of the three supporting manpower pools in any year, the latter three parameters--the rates at which persons in each of the three pools seek teaching positions--determine the total supply of teachers.

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[*] Activities such as homemaking are, of course, included in the concept of career as used here.

All the previous studies assume constant rates for the annual proportion of new graduates qualified to teach, the annual proportion of eligible new graduates who seek teaching positions, and the annual proportion of persons in teaching positions who terminate. And the three studies (NEA, Rattner, and Froomkin) that consider the reserve pool also assume that the annual proportion of reserve teachers who attempt to enter the education sector is constant. These assumptions are not explicit in the DOL or the Froomkin studies. But both assume that the proportion of new BAs who enter teaching positions is constant. And the proportion of new BAs who enter teaching is the product of the proportion of new BAs qualified to teach, the proportion of qualified new BAs who seek teaching positions, and the proportion of qualified new graduates seeking positions who are hired. During the teacher shortage we can assume the last proportion to be negligibly different from 1. Hence, the assumption of a constant entry rate is equivalent to the assumption that both the proportion of new BAs qualified to teach and the proportion of those who seek positions in education are constant.*

The assumption that these rates are constant over time, however, is almost certainly erroneous. The situation in the market for teachers underwent a fundamental change when the teacher surplus emerged after more than two decades of persistent teacher shortages. Traditionally, teaching positions could be readily obtained by a qualified professional. During the current surplus, however, many qualified teachers seeking positions have not been able to enter the education sector. Since the prospects of being able to enter upon a career are likely to affect an individual's career choices, the changed nature of the market for teachers suggests that past trends in the four career choice parameters will not continue in the future.

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*The alternative assumption, that the two proportions are both changing such that each year the change in one precisely offsets the change in the other, seems improbable.

While the teacher surplus is apt to affect each of the four career choice parameters, the magnitude of the impact will vary from one parameter to another. The proportion of eligible new graduates who seek teaching positions is probably the least affected. They have already been prepared to teach and have little to lose in the sense that even if they fail to obtain a position they are no worse off than if they had not sought a position in education. Some, of course, may become so discouraged with the prospects of finding a teaching position that they decline to seek one, but there are probably few such cases.

The teacher termination rate will be reduced to the extent that reentry prospects play a role in the teacher's decision to leave his or her position. For example, teachers who are considering terminating to devote more time to their families with the intention of reentering in a few years may decide to "protect" their positions instead. Relatively fewer teachers are apt to leave the profession to experiment with alternative careers now that the prospects of returning to teaching are much reduced. Some teacher terminations are actually movements from one district to another. Teachers may less frequently leave a position and move elsewhere, for example, to another state, if the prospects for reentry in the new location appear to be poor.

On the other hand, many teachers terminate with no intention of reentering the profession, at least in the foreseeable future. And even for those who consider reentry prospects, other factors (e.g., family pressures, the attractiveness of an alternative career, and so on) that enter their decision may outweigh the impact of the surplus.

The impact of that surplus on the proportion of reserve teachers who seek positions is apt to be slight. It is generally believed that most reentering teachers are women who left the labor force to devote time to their families and seek reentry when their children no longer require full-time attention. For such persons the cost of seeking a teaching position is relatively small, hence the decline in their prospects should have little impact on the proportion of those who seek positions in education. This, in turn, suggests that the reserve supply is largely demographically determined, depending upon the age age and sex distribution of the reserve pool.

The above arguments suggest that the teacher surplus has relatively little impact upon the proportions of each of the three supporting manpower pools that seek teaching positions. The expected stability of these parameters is largely due to the notion that they reflect the behavior of persons already trained to teach. Given that such persons are prepared to enter teaching positions, their inclusion in the supply of teachers depends solely upon whether or not they choose to seek a teaching position. And, since seeking a position does not foreclose alternative opportunities, they are no worse off for seeking a position even though they may fail to obtain one.

The situation is radically different when we turn to the fourth career choice parameter--the proportion of new graduates qualified to teach. College students considering a teacher preparation program are faced with the prospect of not being able to obtain a teaching position upon graduation. The attractiveness of a teaching career must thus be weighted by the possibility that entry into that career will be precluded. Moreover, students who follow a teacher preparation program foreclose the opportunity to use that segment of their college program devoted to teacher training to prepare themselves for some alternative career. In the event that they cannot obtain a teaching position, the "cost" of that foregone opportunity can be large.

The importance of this consideration is borne out by Rattner's results. He estimates that if the proportion of new graduates who are qualified to teach were .25 rather than the generally assumed .35, the surplus in 1980 would be about 40 percent smaller than would be the case if the .35 rate continued. Moreover, the studies reviewed above agree that annually in the past roughly 75 percent of the new hires were eligible new graduates while the remaining 25 percent were teachers drawn from the reserve pool. Since these estimates were based upon data collected in years predating the teacher surplus, we can assume that few qualified professionals who sought teaching positions were not able to find one. Thus we can assume that the pool of eligible new graduates has been a much more important source of new entrants into teaching positions than has been the reserve pool.

Finally, as indicated in Fig. 1, the pool of new graduates qualified to teach is the entry point into the educational personnel system. Thus both the aggregate number of teachers in the system and, given the demand for teachers, the aggregate number of teachers in the reserve pool depend upon the teacher production rates that prevailed in previous years.

TEACHER PRODUCTION RATES

Currently Available Estimates

The currently available projections of new teacher supply assume a teacher production rate of approximately 35 percent--the proportion of new graduates who are qualified to teach. This assumption is based upon the annual NEA reports of teacher education graduates as a percentage of the BA and first professional degree class, reproduced in the second column of Table 4. These data suggest that the teacher production rate has been quite stable over the last decade, ranging from a high of 36.3 percent in 1966 to a low of 33.6 percent in 1967. Moreover, substantial numbers of institutions in three states did not respond to the NEA questionnaire in 1968. As no attempt was made to correct for nonresponse, the reported percentage for 1967 is undoubtedly below the actual level.

However, the NEA method of calculating teacher production rates is quite misleading. Their definition of teacher education graduates includes all graduates prepared to teach at both the BA and MA degree levels. But, the base they use to calculate the teacher production rate includes only the number of BA and first professional degrees granted and excludes the number of MA degrees granted. Consequently, the calculated teacher production rate will reflect the distribution of degrees granted as well as the propensities of students at both degree levels to prepare to teach.

Table 4

AGGREGATE TEACHER PRODUCTION RATES: 1962-1972

Year	Teacher Education Graduates as Percent of Total BA and First Profession Degree Class	Percent of BA Degree Class Prepared To Teach	Index of Change (1966 Base)
1962	34.4	N.A.[a]	N.A.[a]
1964	35.2	N.A.[a]	N.A.[a]
1966	36.3	34.4	100
1967	33.6	33.1	96.3
1968	35.2	32.5	93.5
1969	34.8	32.3	92.8
1970	34.6	31.9	92.1
1971	36.0	31.4	90.5
1972	36.1	30.5	88.2

[a] N.A.--Not available.

Beyond the need to treat teacher education graduates separately at the BA and first professional and the MA degree levels, there is considerable doubt as to whether teacher education graduates at the MA degree level should be included at all in the teacher production rate. A very large proportion of teacher education graduates at the MA degree level consists of already qualified teachers who are upgrading their skills.* Such persons do not represent an addition to the stock of teachers but rather an improvement in the quality of the preexisting stock. As such, they should not be included in the supply of new teachers.

Data collected by the American Association of Colleges for Teacher Education (AACTE) in an annual survey of its membership and a few nonmember institutions provide an indication of the extent to which teacher education graduates at the MA degree level represent a supply of new teachers.* AACTE reports of teacher production at the graduate level provide separate counts of total teacher education graduates and teacher education graduates in areas of initial certification. Over the three-year period from 1965 to 1967, approximately 17 percent of teacher education graduates at the MA degree level were prepared for initial certification. Although AACTE does not obtain data from all teacher-producing institutions, it does account for well over 90 percent of all teacher education graduates. Thus the ratio at the MA degree level of teacher education graduates in areas of initial certification to total teacher education graduates among the institutions that report to AACTE should be reasonably close to the value of that ratio for all teacher-producing institutions.

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*For that matter, many MA degrees are annually granted to persons currently employed as teachers who attend graduate school either part-time in evenings or full-time while on a leave of absence.

AACTE ceased publication of its annual report in 1968, and hence there are no more recent data available. But these data suffice to make the point. The vast majority of advanced degrees granted in teacher education do not represent increments to the preexisting stock of teachers and thus should not be included in the estimation or projection of teacher supply.

A similar set of comments can be made regarding the NEA practice of including the first professional degree class in the base used to calculate teacher production rates. First professional degrees are defined as those requiring at least six years of study in one of the following fields of study: chiropody, podiatry, dentistry, medicine, optometry, osteopathy, veterinary medicine, law, or theology. Since it is quite unrealistic to consider any of these fields as competing with teacher education, there is no reason to include them in the estimation or projection of teacher production rates.

In the light of the above comments we have constructed an alternative set of teacher production rates for the period from 1966 to 1972. These rates, displayed in the third column of Table 4, reflect the annual percentage of the BA degree class that were prepared to

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*See AACTE, *Teacher Productivity--19XX*, Washington, D.C., annual reports.

teach.[*] These rates differ from those calculated by the NEA in two respects. First, the rates calculated by the NEA are uniformly larger than the rates we have calculated. This comes as no surprise since, as noted above, the NEA includes teacher education graduates at both the BA and the MA degree levels in their numerator, while we include in ours only teacher education graduates at the BA degree level. The base we use to calculate the rate is also smaller, by the number of first professional degrees, than that used by the NEA. But the latter has a much smaller affect on the rate.

Second, and far more important, there is a clear trend evidenced in the alternative set of production rates. Whereas the NEA rates showed no clear pattern, the rates we calculate have a distinct downward trend. Changes from year to year are small, being greater than one percentage point only between 1966 and 1967. However, there is not one instance in which the rates rise, and the overall effect is a cumulative drop of nearly four percentage points between 1966 and 1972.

The last column of Table 4 lends some perspective to the importance of these changes. The entries in this column are essentially index numbers constructed as follows. We calculated the male and female production rates obtained in 1966 and, for each subsequent year, multiplied these rates by the respective numbers of males and females in that year's BA degree class. The two products for each year are summed to obtain an estimate of what would have been aggregate teacher production that year had production rates not changed from the 1966 levels. We then divided actual annual teacher production by this estimate to obtain the index.

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[*] The rates are the annual NEA estimate of college students prepared to teach receiving BA degrees divided by the number of BA degrees granted as reported by the Higher Education General Information Survey (U.S. Office of Education). The heavy nonresponse rates encountered in some states in 1968 were "corrected" by substituting, in each of those states, the number of teacher education graduates at the BA degree level retrospectively reported in the 1969 survey. We use annual estimated production--which distinguishes teacher education graduates by sex--rather than the annual retrospective report of production--in order to maintain consistency with the analysis of teacher production by sex. The aggregate differences between each annual estimate and the subsequent year's retrospective report are negligible.

The index numbers displayed in Table 4 indicate the magnitude of the decline in student interest in teacher preparation, taking account of changes in the distribution of BA degrees by sex. The last entry in the column indicates that by 1972, teacher production rates had declined to the point that actual production was only 88.2 percent of the production level "predicted" by 1966 production rates. There was an approximately 12-percent decline in teacher production rates between 1966 and 1972.

The annual NEA data on estimated teacher production permits disaggregation by sex and by level of training; that is, whether individuals have prepared to teach at the elementary or secondary levels. Disaggregated teacher production rates for the period from 1966 to 1972 are presented in Table 5. The male (female) production rate at the elementary (secondary) level is the number of male (female) BA degree recipients prepared to teach at the elementary (secondary) level as a percentage of the male (female) BA degree class. The elementary and secondary total production rates show the number of persons prepared to teach at each level as a percentage of the BA degree class.

The most striking attribute of the data displayed in Table 5 is the overall downward trend in teacher production rates. The aggregate production rates reviewed above declined over the period under consideration, hence we would expect generally to observe declines in the various disaggregated rates. However, Table 5 clearly indicates that the decline in the aggregate rate is not a reflection of large changes in a segment of the teacher production process, but rather reflects an across-the-board reduction in students' inclinations to prepare for a teaching career.

To summarize, over the seven-year period from 1966 to 1972, both male and female students have exhibited substantial declines in their inclinations to prepare to teach at both the elementary and secondary levels.

Career Choices of Entering College Freshmen

Thus far we have examined the actual rates of teacher production over the past seven years. A data base developed by the American Council on Education (ACE) offers some insight into what is likely to happen to teacher production rates in the near future. Each fall since 1966, ACE

Table 5

DISAGGREGATED TEACHER PRODUCTION RATES: 1966-1972
(percent)

Year	Males			Females			Total Elementary	Total Secondary
	Elementary	Secondary	Total	Elementary	Secondary	Total		
1966	2.5	16.7	19.2	28.0	26.8	54.9	13.4	21.0
1967	2.4	15.6	18.0	28.1	25.4	53.5	13.3	19.7
1968	2.4	15.0	17.3	27.2	24.9	52.1	13.2	19.3
1969	2.4	15.1	17.5	26.9	24.5	51.3	13.1	19.2
1970	2.3	14.9	17.2	26.9	24.3	51.1	12.9	18.9
1971	2.3	15.1	17.3	25.9	23.8	49.7	12.6	18.8
1972	2.3	14.9	17.2	24.7	22.7	47.4	12.2	18.3

has conducted a survey of the entering freshmen classes of a large stratified sample of colleges and universities.* Among the items included in the survey are questions regarding career plans and intentions. These data indicate the extent to which entering college freshmen intend to pursue a course of studies that will lead to their being prepared to teach upon graduation.

Table 6 presents the ACE estimates of the rates at which entering college freshmen indicate that their probable career occupation is teaching at the elementary or secondary level. These data are disaggregated by institutional type--two-year or four-year college or university--and by sex for each of the years from 1966 to 1972.

The trends in the data are obvious. Since 1968, entering college freshmen have indicated intent to pursue a teaching career at rapidly declining rates. There are, of course, some minor variations on this theme. For example, men entering universities in 1969 were somewhat more inclined toward a career in teaching at the secondary level than were men entering universities the previous year. The same relationship

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*See ACE, *National Norms for Entering College Freshmen--Fall 19XX*, Washington, D.C., annual research reports.

Table 6

ACE ESTIMATED PERCENTAGES OF ENTERING FRESHMEN INTENDING TO PURSUE A TEACHING CAREER, BY INSTITUTIONAL TYPE AND SEX: 1966-1972

	Elementary Level							Secondary Level						
Institutional Type	1966	1967	1968	1969	1970	1971	1972	1966	1967	1968	1969	1970	1971	1972
Two-Year Colleges														
Men	0.9	1.0	1.3	1.3	1.1	0.8	0.6	10.1	8.1	10.2	8.9	7.7	5.5	4.5
Women	13.4	15.1	17.7	16.9	14.2	11.7	9.4	11.4	11.6	10.7	10.9	9.2	7.0	5.7
Total	6.1	6.7	7.8	7.4	7.0	5.5	4.6	10.7	9.9	10.4	9.7	8.4	6.1	5.0
Four-Year Colleges														
Men	1.0	1.1	1.8	1.2	1.2	1.3	1.2	14.4	14.9	17.0	13.9	12.2	9.7	6.7
Women	18.5	21.8	24.0	24.0	21.5	18.0	14.5	22.6	23.7	22.6	21.3	18.8	14.7	11.1
Total	9.9	11.1	12.4	12.2	10.9	9.7	7.6	18.5	19.2	19.6	17.5	15.4	12.2	8.8
Universities														
Men	0.4	0.2	0.3	0.4	0.2	0.3	0.3	5.7	5.7	6.1	6.4	5.0	4.1	3.2
Women	12.5	12.9	13.8	14.9	11.1	9.2	8.1	16.6	17.7	18.0	18.2	14.2	10.6	7.7
Total	5.4	5.6	6.0	6.6	4.7	4.3	3.8	10.2	10.8	11.1	11.5	8.8	7.0	5.2
All Institutions														
Men	0.8	0.8	1.2	1.0	0.9	0.9	0.7	10.5	10.4	11.5	9.9	8.7	6.6	5.0
Women	15.7	17.6	19.4	19.3	16.6	13.8	11.1	18.4	18.8	18.1	17.2	14.4	11.0	8.4
Total	7.6	8.3	9.1	9.0	8.0	6.8	5.6	14.1	14.1	14.4	13.1	11.3	8.6	6.5

held for women entering two-year colleges in 1969 vis-à-vis women entering two-year colleges in 1968. But for both women entering two-year colleges and men entering universities, interest in teaching careers at the secondary level dropped sharply in the subsequent years.

By 1972, the rates at which entering freshmen indicated plans to pursue teaching careers at the secondary level had fallen to between one-third and one-half of the comparable rates observed in the late 1960s. This radical decline occurred among both men and women at all three types of institutions. Among women, interest in teaching at the elementary level had dropped by nearly one-half between 1968/1969 and 1972 at all three institutional levels. Entering freshmen males interested in a teaching career at the elementary level are the only exception to the general pattern of decline. And even among this subgroup there is evidence of a drop in the extent to which teaching is viewed as a probable career.

It is necessary to be rather careful in interpreting the ACE data. In particular, it cannot be assumed that because an estimated 6.5 percent of all entering college freshmen in 1972 believe that their probable career occupation will be teaching at the elementary or secondary level, only 6.5 percent of the BA degree class of 1976 will be prepared to teach. Attrition among both students preparing to teach and those following other courses of study as well as transfers between teacher education programs and other undergraduate programs will affect the eventual teacher production rate. Moreover, teaching has traditionally been viewed as an unusually secure occupation in which jobs are readily available. It is generally believed that substantial numbers of students prepare to teach, though they are not primarily interested in a teaching career, in order to provide themselves with a "fall-back" position. Such persons may have indicated a probable career occupation other than teaching, although they intended to follow teacher preparation curricula. Finally, ACE has had to exclude a number of sampled institutions each year because their student response rates were too low.

The weights used to inflate the sample results to estimates for the nation as a whole were adjusted accordingly. But nonresponses may have introduced bias into the results. Despite these qualifications, it seems safe to conclude that in the past four or five years there has been a tremendous reduction in the extent to which entering college freshmen expect to pursue a teaching career.

Whatever factors underlie the decline in the number of entering freshmen that intend to pursue teaching careers, these factors are likely also to have included greater attrition and transfer rates among the students already engaged in teacher preparation programs. Between 1966 and 1968, for example, the proportion of female entering freshmen who expected their career occupations to be teaching at the elementary level grew by over 20 percent, yet, as shown in Table 5, there was a drop in the proportion of the female BA degree class prepared to teach at the elementary level between 1970 and 1972.* One explanation for this apparent inconsistency is that the factors that induced the declines in the rates at which entering freshmen were interested in teaching careers between 1968 and 1970 also induced greater attrition and program transfers among the sophomores, juniors, and seniors in teacher preparation programs during those years.

In any event, the data presented in Table 6 suggest that the decline observed in teacher preparation rates over the past seven years may continue, perhaps even accelerate, over the forthcoming four or five years. In view of the importance of this parameter, we now turn to a detailed analysis of the factors that influence the proportion of new college graduates qualified to teach.

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*If attrition and transfer rates among both teacher preparatory students and students not preparing to teach were constant, and if a constant proportion of females prepared to teach as a "fall-back" position between 1966 and 1972, we would have expected growth in the female elementary teacher preparation rate between 1970 and 1972.

IV. AN ANALYTICAL MODEL OF TEACHER PRODUCTION

OVERVIEW

In our descriptive model of the supply of teachers presented in Section II we identified the basic parameters that influence the supply of teachers. Four of these parameters involve an explicit choice among specific occupations by individuals in different manpower pools:

α_t = proportion of eligible new graduates seeking a teaching position,

γ_t = proportion of persons in the reserve pool seeking teaching positions,

ε_t = proportion of currently employed teachers selecting a nonteaching position,

ϕ_t = proportion of college graduates qualified to teach.

The previous studies of teacher supply have assumed that these parameters of occupational choice were constant. Given the significant change in the teacher labor market, this constancy implied that these choice parameters were independent of the labor market conditions within the teacher and other relevant occupational labor markets. In this section we develop an economic model of occupational choice that relates these choice parameters to relative labor market conditions, more specifically, to the district monetary (principally salary or wages) and nonmonetary rewards (e.g., working environment, concurrent hours) associated with various occupations. We also distinguish between short-run and long-run occupational choices by introducing the concept of shifts in supply caused by lagged independent variables and the concept of an individual's expectations concerning different occupational returns. From these concepts we develop an analytical model of teacher production. In terms of our four choice parameters, this model relates ϕ, the proportion of college graduates eligible to teach, to expected monetary and nonmonetary returns from teaching relative to alternative occupations.

AN ECONOMIC MODEL OF OCCUPATIONAL CHOICE[*]

A simple economic model of occupational choice can be developed from two basic assumptions. These are:

1. Each occupation available to an individual offers discernible monetary (wage) and nonmonetary (nonwage) rewards, and
2. Each individual attempts to maximize a utility function containing both monetary and nonmonetary elements.

From assumption 1, we can derive the occupational return frontier that confronts every individual. The frontier is determined by the mix of monetary wage, W and nonmonetary (nonwage, NW) rewards associated with the range of occupations open to the individual. This frontier is depicted in Fig. 2 by the line ABCDE. Each point on that line corresponds to the unique mix of monetary and nonmonetary advantages contained in the occupational offers depicted. We assume that teaching is represented by the occupational return shown at point B.

From assumption 2 we obtain the individual's utility function containing both wages and nonmonetary advantages or arguments. Since both advantages are "goods," the utility function U is drawn as a convex curve in Fig. 2 indicating that, to maintain the same level of utility or satisfaction, an individual must obtain some nonmonetary rewards if he loses some wage advantages. The actual shape of the utility curve depends, of course, on the particular individual's preferences for wage advantages relative to nonmonetary advantages. Utility functions lying to the right and above the initial utility function reflect higher levels of satisfaction since more of both "goods" are available.

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[*] Because we are developing a general occupational choice model, we include non-labor market activities, such as homemaking or leisure in the concept of occupation as used here.

We can establish the individual's occupational choice by determining where the occupational return frontier is tangent to the individual's utility function. In Fig. 2, this occurs at point C, thus indicating that the individual with that particular set of preferences for wage relative to nonwage advantages would opt for a nonteaching career of type "C" given the current occupational return frontier.

However, we can also determine how much teacher's wage or nonwage advantages must be increased in order to induce the individual to enter the teaching occupation. According to the figure, an increase in teacher wages from W_1 to W_2 would make this individual indifferent in the choice between teaching and his alternative occupation. W_2, the teacher wage rate needed to make this individual indifferent in choosing between teaching and his best alternative occupation, is the individual's "reservation wage"; when the teacher wage rate exceeds the individual's reservation wage, he will enter teaching. A similar analysis with respect to nonmonetary rewards indicates that the individual would also be indifferent between teaching and occupation C if the nonmonetary rewards of teaching were to be increased to NW_2.

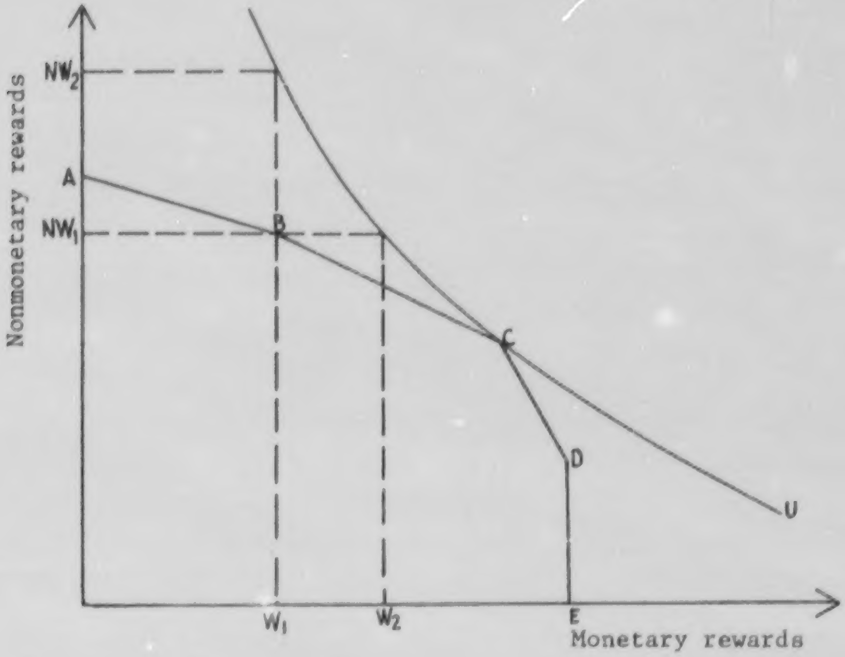

Fig. 2 -- Occupational returns to the individual making a career choice

By replicating this analysis for all individuals making a career decision, we can derive a relationship between the number of individuals entering teaching and the reservation wage for teaching. If we assume that the population is similar in ability, the occupational return frontier facing each individual will be the same. The distribution of teacher reservation wages will then depend strictly upon the distribution of individual preferences (i.e., the individual utility sets, U_i).*

Figure 3 presents a frequency distribution of individuals with respect to their teacher reservation wage. As the actual teacher wage rate increases (measured along the horizontal axis), the number of individuals selecting teaching as their occupation increases (represented by the *increase* in the *area* under the curve). The actual height and shape of the distribution function, ℓ, depend upon:

- Size of the eligible population,
- Distribution of individual preferences, and
- Current occupational return frontier.

An increase in the population will merely increase the height of the curve, thereby increasing the area under it; for example, curve ℓ_2 instead of ℓ_1. Likewise, a change in preferences will shift the curve from ℓ_1 to one like ℓ_3, if the change is favorable to teaching.

Given this frequency distribution, we can derive an aggregate supply curve for teaching. Thus in Fig. 4, Q_1 represents the number of individuals entering teaching at the teacher wage of W_1 and corresponds to the area under ℓ_1 to the left of W_1 in Fig. 3. An increase in teacher wages to W_2 increases the number of individuals entering teaching to Q_2, other things being equal. The remainder of the supply curve S is similarly derived from the frequency distribution ℓ_1.

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*If abilities also vary, the occupational return frontiers will also vary among individuals, and the frequency distribution of teacher reservation wages will depend upon both the distribution of abilities and the distribution of individual preferences.

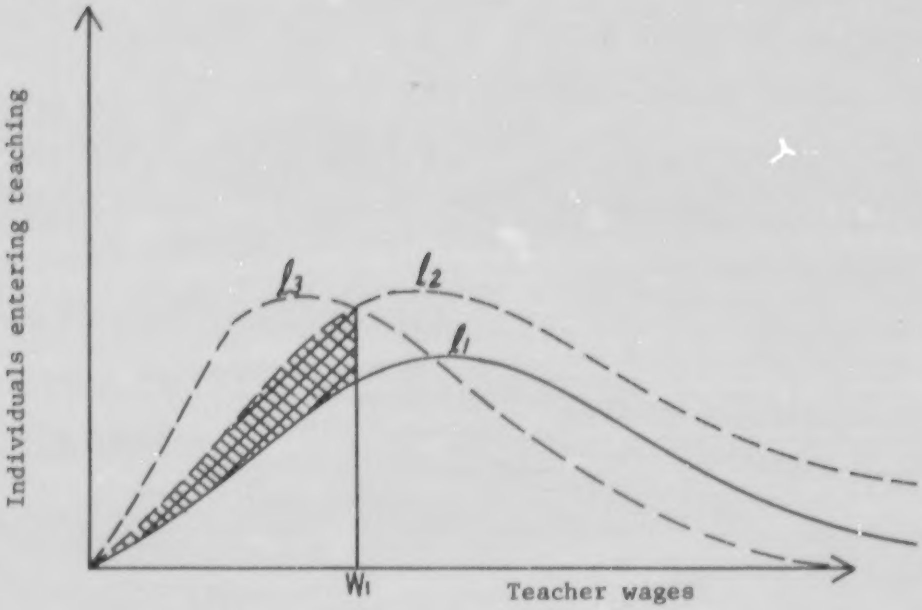

Fig. 3 -- Distribution of individuals with respect to teacher reservation wages

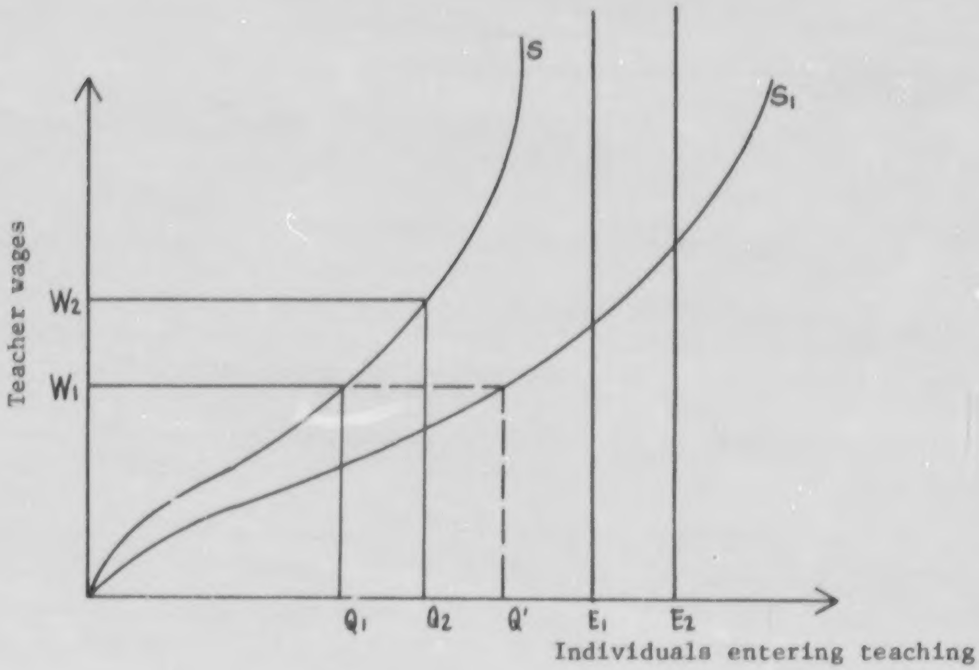

Fig. 4 -- Supply curve of teachers

A change in tastes or a change in population *shifts* the entire supply curve. For example, an increase in population, reflected by the ℓ_2 frequency distribution, shifts the supply curve to S'. With supply curve S', a greater number of individuals will enter teaching at any wage rate relative to the supply curve S. Thus at wage W_1, $Q_1'-Q_1$, additional individuals* will select teaching given the supply curve S' generated by the increase in population.

The supply curves depicted in Fig. 4 are static, defined without any reference to time. At any given time, the size of the population and its tastes and abilities are fixed. Assuming other occupational rewards are unchanged, we can derive a short-run supply curve for teaching by varying the teacher wage offer** and obtaining a schedule similar to the S or S' curves in Fig. 4. The long-run supply curve will reflect changes in the fixed parameters such as tastes, population, and ability, which are influenced by teacher wages or other teacher labor market conditions.

Three of our choice parameters reflect short-run supply phenomenon. Each of these parameters, α_t, γ_t, and ε_t (or, to be consistent, $1-\varepsilon_t$) reflect a career choice by individuals from three different manpower pools (i.e., populations). Our fourth choice parameter, ϕ_t, the proportion of college graduates eligible to teach, reflects a long-run supply phenomenon. Thus we need to extend our current static analysis, portrayed in Fig. 4, to account for long-run supply adjustments and provide the basis for an analytical model explaining ϕ_t.

The concept of a shift in the supply curve helps differentiate short-run from long-run supply responses for occupations where formal training requirements limit the supply of "eligible" personnel.

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*This increase is depicted in Fig. 3 by the cross-hatched area between the ℓ_2 and ℓ_1 frequency distribution.

**Alternatively, we could hold teacher wages constant and vary the nonmonetary rewards to obtain a similar supply curve, with these rewards replacing wages on the vertical axis.

Most professional labor markets and many skilled labor markets reflect this type of behavior. In the short run, the supply curve will approach a limit determined by the total number of people possessing the requisite skill. Over time, that limit shifts as more (or fewer) people acquire those skills through initial training or retraining. The change in the eligible population possessing the skill reflects a long-run change. This is shown graphically in Fig. 4. In year 1, E_1 defines the total eligible population available while Q_1 represents the amount of labor supplied at the wage rate W_1. In year 2, the total eligible population has increased (perhaps in response to the attractive wage, W_1) to E_2 so that at the same wage W_1, $Q_1'-Q_1$ more labor is supplied. In this case, the increase in the quantity supplied obtained from the outward shift of the supply curve reflects only the long-run response to previous conditions (i.e., wage rate W_1 in year 1).

Normally, the demand for teachers will be negatively related to the wage rate, like the schedule D_T in Fig. 5. With D_T unchanged,

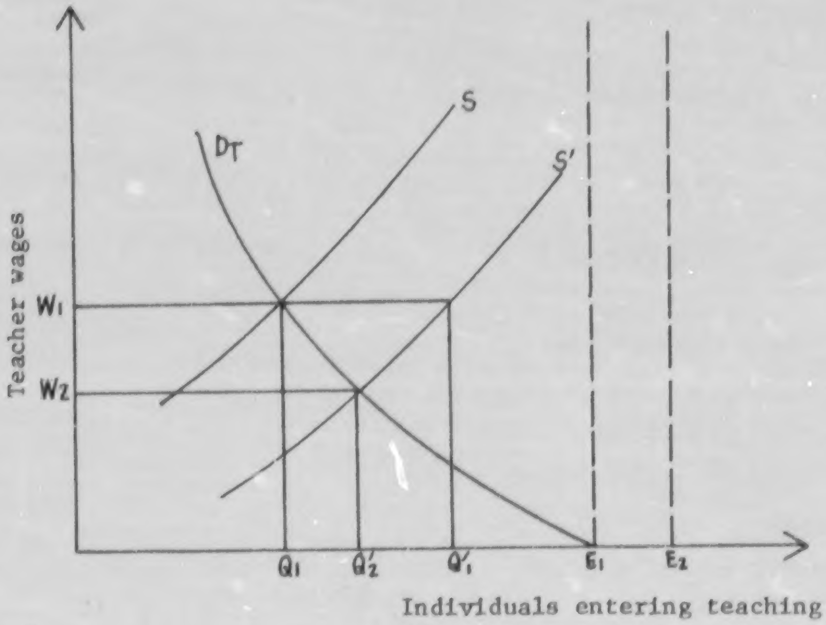

Fig. 5 -- Individuals entering teaching

the shift in supply reduces the wage to W_2, and the short-run response is a reduction in the amount of labor supplied from Q_1' to Q_2'. The supply of labor in year 3 will depend on whether W_2 is above, below, or equal to the long-run equilibrium wage W_e.* If $W_2 < W_e$, then the total eligible population will decrease as fewer seek training in that profession. With demand still unchanged, the wage rate W_3 will be higher than W_2. This process will continue until the wage rate equals the equilibrium wage.

The preceding model can be summarized by an equation relating the number of individuals entering teaching in year t to the teacher and alternative wages in year t and t-1, the nonmonetary rewards of teaching and alternative occupation in year t and t-1, and the underlying distributions of preferences and abilities. Thus,

$$Q_t = \ell(W_{T,t}, W_{T,t-1}, W_{A,t}, W_{A,t-1}, NW_{T,t}, NW_{T,t-1}, NW_{A,t}, NW_{W,t-1}, Z_t), \qquad (10)$$

where Q_t = number of individuals entering teaching in year t,
$W_{T,t}$ = teacher wage rate in year t,
$W_{A,t}$ = wage of the best alternative occupational wage in year t,
$NW_{T,t}$ = nonmonetary rewards for teaching in year t,
$NW_{A,t}$ = nonmonetary rewards of the best alternative occupation in year t, and
Z_t = parameters such as preferences and abilities, which are assumed to be fixed.

Such recursive equations are often used to describe labor market behavior where the amount of formal training needed to enter the

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*The equilibrium wage W_e is the wage rate determined by the intersection of the *long-run* supply function with the demand schedule D_T. At this wage, there is no change in the "eligible" population.

profession is sufficiently long to preclude total short-run adjustment. Since educational personnel undergo a long period of formal training to become "eligible" to enter the teaching profession, the teacher labor market clearly reflects this type of behavior.

A CAVEAT ON RISK AND UNEMPLOYMENT

The model in Eq. 10 has been predicated on the implicit assumption that the occupational return frontier facing each individual was certain and known. No risk, or more accurately, no differential risk was associated with each specific occupational offer of wage and nonmonetary rewards defining that frontier. If all markets were perfect, and the wage and nonmonetary offers were determined by the specific demand and supply conditions within each market, there would be no problem. The offers would adjust instantaneously to changes in those conditions and there would be no question about the probability of securing an offer because of potential unemployment. If, however, the offers do not adjust to market conditions, excess demand or supply conditions can arise, thereby reducing the certainty of securing the observed offer. When there is uncertainty concerning the probability of employment, the expected wage will not equal the observed wage, and the model represented by Eq. 1 must be adjusted.

Theoretically, the adjustment factor to account for uncertain employment prospects when excess supply conditions prevail in a given market can be obtained by calculating a probability of employment. This probability can be estimated as the number of individuals hired relative to the total number of individuals seeking employment in that market at the existing "fixed" occupational wage (offer).

There are two alternatives for adjusting the model in Eq. 10 using this employment probability. The first approach assumes that individuals use these market employment probabilities to discount the observed occupational wage and nonmonetary reward offers. Thus they calculate an "expected offer" by multiplying the observed offer by the associated employment probability. The second approach assumes that individuals use a subjective probability unrelated to the observed market employment probability to calculate their "expected offer" but use the market probability as a proxy for employment security in that occupation. With this approach the employment probability is one of the nonmonetary rewards and is therefore one element in the array of nonmonetary occupational rewards. The first approach yields a modified model represented in Eq. 10a, while the second approach produces a modification similar to the one in Eq. 10b. Thus,

$$\begin{aligned} Q_t = \ell(&PR_{T,t} \cdot [W_{T,t}, NW_{T,t}], PR_{T,t-1} \cdot [W_{T,t-1}, NW_{T,t-1}], \\ &PR_{A,t} \cdot [W_{A,t}, NW_{A,t}], PR_{A,t-1} \cdot [W_{a,t-1}, NW_{A,t-1}], Z_t) \end{aligned} \tag{10a}$$

$$\begin{aligned} Q_t = \ell(&W_{T,t}, W_{T,1}, W_{A,t}, W_{A,t-1}, NW_{T,t}, NW_{T,t-1}, NW_{A,t}, \\ &NW_{A,t-1}, PR_{T,t}, PR_{T,t-1}, PR_{A,t}, PR_{A,t-1}, Z_t) , \end{aligned} \tag{10b}$$

where $PR_{T,t}$ = employment probability for teaching in year t, and

$PR_{A,t}$ = employment probability for the best alternative occupation in year t.

The remaining variables are the same as those defined for Eq. 10 above.

A MODEL OF TEACHER PRODUCTION: THE LONG-RUN SUPPLY RESPONSE

Although there are a number of elements influencing an individual's choice of a particular college (e.g., a teacher training institute) and specific preparatory program (e.g., teacher preparatory program) an important one is the individual's initial career choice. We assume that this choice is predicated on the individual's assessment or expectation of the alternative career offers he will obtain upon graduation. Thus, each individual forecasts what his probable occupational return frontier will be once he completes his training and is eligible to enter one of these occupational fields. Although our model (Eq. 10) indicates what variables will be used to make this expectation calculation, the actual relationship between the currently observed occupational offers and the individual's expectation about occupational offers after completion of training is unknown.

Alternative Models for Devising Occupational Returns Expectations

There are several hypotheses concerning the formulation of occupational return expectations. The simplest hypothesis is that individuals assume that their occupational return frontier will be the same as the current one. This expectation hypothesis is depicted in Eq. 11, where $\overline{W}_t$ represents the array of wages (occupational returns) observed in year t. This hypothesis does not imply zero growth in specific occupation returns; rather it implies that the growth rates (unspecified) will be the same for all occupations. A more complex hypothesis is that individuals account for differential growth rates by assuming that currently observed growth rates will continue. Thus next year's array of occupational wages is assumed to depend on the specific levels and growth rates among this year's occupational wages. Equation 12 depicts this hypothesis. In addition to adjusting for differences in observed growth rates, individuals may also base their expectations on observed differences between actual and previously expected wages. Thus, a new year's array may be projected using the observed levels and growth rates for this year's wages plus an adjustment for differences between this year's expected and actual wage array. This expectations hypothesis is represented mathematically in Eq. 13.*

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*These expectations hypotheses assume the individual responds directly to his expectations. An alternative is that he responds to the difference between the realized value and his expectation. More formally, he responds to D_t where

$$D_t = \overline{W}_t - E(\overline{W}_t).$$

Using Eq. 13 for the expectations formulation, we obtain

$$D_t = \overline{W}_t - E(\overline{W}_{t-1} + \Delta\overline{W}_{t-1}).$$

$$E(\bar{W}_t) = \bar{W}_{t-1} \tag{11}$$

$$E(W_t) = W_{t-1} + \Delta\bar{W}_{t-1} \tag{12}$$

$$E(\bar{W}_t) = \bar{W}_{t-1} + \Delta\bar{W}_{t-1} + (E(\bar{W}_{t-1}) - \bar{W}_{t-1}) \tag{13}$$

where $E(\bar{W}_t)$ = expected occupational wage array in year t,

$\bar{W}_{t-1}$ = actual wage array in year t-1,

$\Delta\bar{W}_{t-1}$ = change in wage array $(\bar{W}_{t-1} - \bar{W}_{t-2})$.

Individuals make their first tentative occupational choice among those occupations "requiring" a college degree at the time of college entry. Theoretically the number of individuals selecting teacher preparatory programs would appear as graduates eligible to teach if there were no dropouts (i.e., no population changes) and no changes in these individuals' tastes, abilities, or expectations about occupational returns. However, changes do occur during the college career, and the size of the pool of graduates eligible to teach four years from entry will vary in response to:

- Changes in the underlying college entry population due to dropouts;
- Changes in the occupational return expectations due to changes in occupational offers indicated by changes in specific occupational labor market conditions;
- Changes in college policies, such as those establishing the specific requirements and degree of academic rigor for particular curricula (e.g., the teacher preparatory program).

Although students can presumably change their preparatory program at any point during their college career, this ability depends on the specific curriculum requirements established by each college.

Given some set of requirements, the ability to change curriculum decreases the longer the student pursues a particular program. Moreover, the more restrictive these curriculum requirements, the earlier must a firm decision on one's college program be made. Thus, college policy on teacher training curriculum requirements can influence the lag structure for the long-run supply of teachers. For example, with a curriculum that restricts major program changes after the junior year, the supply of new graduates eligible to teach in year t will not be responsive to economic and other changes in year t-1 (i.e., the senior year).

Determinants of the Number of Eligible New Graduates

Using our occupational choice model (Eq. 10) and our simple expectations hypothesis (Eq. 11) we can derive an equation for the number of college graduates eligible to teach in year t. Equation 14 below is our basic model to determine the long-run supply response of college graduates eligible to teach. Although the dependent variable, G_t, is expressed in absolute numbers, we can directly obtain a model to estimate the proportion of BA graduates eligible to teach (i.e., the ϕ parameter) by dividing both sides of Eq. 14 by the number of total BA graduates in the year t, E.

$$G_t = \ell(W'_{T,t}, W'_{A,t}, NW'_{T,t}, NW'_{A,t}, PR'_{T,t}, PR'_{A,t}, E_t, Z_t, \Delta C_t) \qquad (14)$$

where G_t = number of college graduates eligible to teach;

$W'_{T,t}$ = vector of teacher wage rates for years t, t-1, ... , t-n;

$W'_{A,t}$ = vector of alternative occupational wage rates in year t, t-1, ... , t-n:

$NW'_{T,t}$ = vector of nonmonetary rewards in teaching in year t, t-1, ... , t-n;

$NW'_{A,t}$ = vector of alternative occupational nonmonetary rewards in year t, t-1, ... , t-n;

$PR'_{T,t}$ = vector of teaching employment probabilities in year t, t-1, ... , t-n;

$PR_{A,t}$ = vector of alternative occupational employment probabilities in year t, t-1, ... , t-n;

E_t = number of college graduates;

Z_t = a series of parameters like individual preferences assumed unchanged for the particular college group;

ΔC_t = the tth-year change in college specific variables, such as curriculum requirements for teacher preparatory programs; and

n = an unknown number dependent upon the restrictiveness of the colleges' teacher preparatory curriculum.

MODEL MODIFICATION FOR CROSS-SECTIONAL ANALYSIS ACROSS STATES

Most previous studies of teacher supply have used aggregate national data on the proportion of BAs eligible to teach (ϕ) to project annual new supplies of beginning teachers. We estimate our model at the state level, primarily because the educational professional manpower system is not well described by a national aggregate model. Rather, the system consists of a series of local labor markets with a network for formal and informal linkages among the individual markets. While the extent of these local labor markets is uncertain, state-level aggregations appear reasonable for three reasons. First, inter-state migration of beginning teachers does not currently appear to be a significant mechanism for adjusting local teacher labor market imbalances. Second, many educational manpower decisions are made and implemented at the state level. Teacher certification and accreditation of educational (teacher training) curricula are two of the most obvious examples. If manpower models are to be relevant for state-level decisionmakers as well as those at the national level, the models must be designed to function at the state level. Third, we wanted to test the adequacy of currently available data for making state manpower projections. Aggregations of local school district data are available at the state level for most of the data required. Regional-level aggregations and/or aggregations by

SMSA (Standard Metropolitan Statistical Area) are not generally available. Thus, data constraints limited any aggregate analysis to the state level.

In order to estimate our model cross-sectionally across states, we must assume that the responses of various population subgroups to relative teacher labor market conditions are independent of their particular state of residence. With other things being equal across states, we could expect this condition to hold. There are, however, many structural differences among states, and some of these may affect the average proportion of BAs eligible to teach in each state. Two obvious examples of state structural differences are (1) the structure of the state's system of higher education, and (2) the extent of the state's labor market for high-level (college graduate) manpower.

The proportion of graduates eligible to teach varies widely across institutional categories. Thus, teacher colleges (or public four-year colleges) tend to produce a higher proportion of graduates eligible to teach than do private universities or technical institutes. Consequently, a state with a high percentage of its college enrollment in public four-year colleges (or teacher-training institutes) will produce a greater proportion of graduates eligible to teach than will a state with a smaller percentage of its college enrollment in that same type of institution, even though all other conditions in the two states are the same. This type of structural difference will have a direct independent effect on the state proportion of BA graduates eligible to teach.

Moreover, some of these structural differences may interact with one of the other independent variables in the model. For example, the response to a change in teacher wage rates may depend upon the size of the labor market for high-level manpower (college-educated manpower) in each state. A large market with a wide range of alternative occupations will attract a larger segment of the high-level manpower pool than a small market, given a random distribution of tastes within the pool. Therefore, an equal percentage change in relative wages will produce a larger supply response in states with a large high-level manpower labor market, where more people are "on the margin," than in states with a small labor market.

The reliability of projections using the parameters from Eq. 14 estimated cross-sectionally across states depends directly upon our success in controlling for these structural state differences. Equation 15 is a revised version of Eq. 14; it contains independent variables to control for these structural differences. The dependent variable, $\phi_{i,t}$, is the proportion of BA graduates in state i eligible to teach in year t. Teacher and alternative occupational wage expectations are represented in relative rather than absolute terms by the variables. The employment probability and other nonmonetary occupational rewards are also expressed in relative terms. The Z_i vector represents state averages of variables accounting for differences in individual preferences or tastes. The remaining variables control for anticipated structural differences among states which would affect the proportion of college graduates eligible to teach. The major ones are differences in

- Enrollment capacity of teacher-training institutes relative to other institutes of higher education in the state,
- Size of the teacher labor market relative to other high-level manpower labor markets in the state,
- Degree of urbanization and concentration of population within the state, and
- State credentialing requirements for a teaching certificate.

Thus, for the mth state in year t,

$$\begin{aligned}\phi_{m,t} = a_o + \sum_{j=t-4}^{t} [a_j rw_{m,j} + b_j rep_{m,j} + c_j rnw_{m,j}] + \sum_i d_i Z_{i,t} \\ e_1 ED_{m,t} + e_2 NMIX_{m,t} + e_3 RUR_m + e_4 CRED_m + U \;,\end{aligned} \tag{15}$$

where ϕ = proportion of college graduates eligible to teach,

rw = teacher wage rate relative to the alternative occupational wage rate,

rep = employment probability for teachers relative to the alternative occupation, rnw = nonmonetary rewards of teaching relative to the alternative occupation.

$Z_{i,t}$ = a series of variables reflecting differences in average individual preferences in that state,

ED = level of higher education enrollment in private relative to public institutions,

NIMX = a variable reflecting the structure of the mth state labor market,

RUR = proportion of the population in rural areas,

CRED = minimum number of semester hours of professional education courses required for teacher certification and,

U = a random error term.

Equation 15 was estimated separately for males and females, since we expected tastes and responses to labor market conditions to vary for both. An additional separation was made between elementary and secondary education because the preparation training differed and the range of alternative occupational choices and the preferences of those being trained were also expected to differ.

SUMMARY

In this section we have developed an economic model of occupational choice from only two fundamental assumptions:

- There are discernible monetary and nonmonetary rewards for each considered occupation, and
- Individuals try to maximize their own utility, depending upon different combinations of monetary and nonmonetary elements.

We used this model to derive a positive relationship (called a supply function) between the number of individuals choosing a teaching career and the wage (monetary reward) for teaching, given the current eligible population, the distribution of tastes among that population, the wages of other occupations and the nonmonetary rewards of teaching and all other occupations.

By extending this analysis to account for *shifts* in that supply function due primarily to population changes and by introducing different expectation formulation hypotheses to establish the linkage between *current* labor market conditions and *current* individual career choice based on anticipated relative career returns, we used our economic career choice model to derive an explicit model of teacher production rates or, alternatively of ϕ, the number of college graduates eligible to teach.

V. EMPIRICAL TEST OF TEACHER PRODUCTION MODEL

In this section we use currently available data on the production of teachers, the economic return to teaching relative to other occupations, and several structural variables to test our basic teacher production model cross-sectionally among the 50 states and the District of Columbia. We focus on two principal issues:

- Are teacher career decisions (and hence teacher production rates) influenced by economic variables reflecting relative labor market conditions?
- Is there a substantial lagged response between current labor market conditions and individual career decisions?

The basic model (Eq. 15) presented in Section IV identified the major independent determinants of teacher production. We encountered some serious problems, however, in obtaining direct empirical measures for many of these determinants. Consequently, several proxy variables were used. The following subsection describes the various empirical variables used to approximate the independent determinants in our basic model. A complete description of the data sources, the quality of the data, and fundamental data gaps is presented in Appendix B.

DIRECT AND PROXY VARIABLES

We have available direct measures of the number of BA graduates and the number of graduates eligible to teach elementary or secondary school by state and sex. However, the quality of the eligibility data is fundamentally suspect, and in several cases the raw data were adjusted for obvious errors.*

Theoretically, we should have used the average *wage rate* of beginning elementary and secondary teachers relative to the average starting

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*These problems are described in Appendix B.

wage rate of all other BA graduates in the state as our relative wage term. However, because average starting salaries of teachers and all other BA graduates were not available by state, we used the average classroom teacher salary relative to the average salary of state and local government workers to approximate the relative wage rate. The use of the average salary of government workers will not bias our wage term as long as average government salaries are highly and positively correlated with the average salaries of beginning BA graduates across states. The use of average salaries rather than average starting wage rates will bias our estimates, however, if the number of hours worked, the differential between experienced and starting wage rates, or the composition of the work force between beginning and experienced personnel differs systematically across states for either occupation.*

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*Let us define the relative wage rate in state m as

$$rwr = \frac{(SS_T/HR\ )_m}{(SA_A/HR_A)_m} ,$$

where $SS_{T \text{ and } A}$ = starting annual salaries in teaching and the alternative occupation, and

$HR_{T \text{ and } A}$ = number of hours worked annually in both occupations.

Since teachers work fewer hours annually (i.e., $HR_T < HR_A$), we know that relative annual starting salaries understate the true relative wage rate, but would provide biased estimates of the a coefficients in Eq. 6 if the ratio of relative annual hours worked varied across states. Thus,

$$rwr_m = (\frac{SS_T}{SS_A})_m \cdot (\frac{HR_A}{HR_T})_m - (\frac{SS_T}{SS_A})_m < rwr_m \text{ if } HR_T < HR_A .$$

If we assume that there are only two categories of workers in both occupations, beginning and experienced, average occupational salary is defined as

$$AS_T = bSS_T + (1-b)XS_T$$
$$.AS_A = aSS_A + (1-a)XS_A ,$$

where b and a = proportions of beginning personnel in the teaching and alternative work forces, respectively, and

$XS_{T \text{ and } A}$ = experienced average annual salary in teaching and the alternative occupation, respectively.

If λ_T and λ_A are the proportional wage differentials in the two occupations, i.e., $XS_T = (1 + \lambda_T)SS_T$, we can derive the following relationship between

We encountered severe data problems in developing variables to approximate the relative employment probabilities and the relative nonmonetary rewards between teaching and an alternative occupation. Since data on nonmonetary rewards from teaching and alternative occupations were not available, we were unable to develop variables to measure the importance of these factors. Inadequate data also prevented us from developing a variable to measure directly the relative employment probabilities. We did, however, construct some proxy variables to approximate relative tightness (i.e., the extent of relative excess demand) in the teaching and alternative occupation labor markets.

Theoretically, the level of excess demand is measured by the difference between the demand for and the supply of individual teachers at the given teacher wage rate. Excess demand can be positive or negative, with negative excess demand indicating the presence of unemployed teachers. If excess demand were observable, individuals would use it to calculate their probability of employment.* Clearly, increases in the amount of

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average and starting salaries:

$$AS_T = bSS_T + (1-b)\ (1+\lambda_T)SS_T$$
$$AS_A = aSS_A + (1-a)\ (1+\lambda_A)SS_A\ .$$

Relative average salaries are then

$$\frac{AS_T}{AS_A} = \frac{SS_T}{SS_A}\left[\frac{b}{a} + \frac{(1-b)\ (1+\lambda_T)}{(1-a)\ (1+a_A)}\right].$$

Relative average salaries will be a biased proxy variable for the relative average starting salaries if a, b, λ_A, or λ_T vary systematically across states.

*If there is unemployment in a market, an individual's probability of employment will equal the number employed divided by the number employed and unemployed. Mathematically,

$$PR = \frac{N}{N+U}\ .$$

But given excess supply conditions, the number employed equals the number demanded, and the number unemployed equals the amount of negative excess demand:

$$N = D$$
$$U = -(D-S) = -ED\ .$$

Substituting yields

$$PR = \frac{D}{D-(D-S)}\ .$$

Notice that an increase in excess demand decreases the denominator of the right-hand expression, and this increases the probability of employment.

excess demand or corresponding decreases in the amount of *negative* excess demand (i.e., unemployment) improve the employment prospects of the particular occupation. If these changes could be observed, at least indirectly, individuals could estimate the improvement in their employment prospects in various occupations. The change in the level of excess demand equals the difference between the change in demand and the change in supply, by definition.* Since there are some proxy variables to estimate changes in supply and demand, we can use these variables to estimate the change in excess demand, and thus approximate the change in employment prospects.

Given a constant wage rate, changes in supply and demand imply shifts in the entire schedules. Since changes in the eligible population will produce shifts in the supply schedule, we use the change in the number of BAs eligible to teach to approximate the change in the supply curve for teachers. As long as the given wage rate is equal to or greater than the equilibrium wage, changes in employment will reflect the change in the demand curve for teachers.** Hence we approximated the change in the excess demand for teachers with the change in teacher employment less the change in new graduates eligible to teach. We likewise used the change in government and services employment less the change in new BAs produced to approximate the change in excess demand in the alternative occupation. Thus our relative employment probability variable, rpr, was approximated by the relative differences in the changes in demand and supply in the

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*The change in excess demand is defined as

$$\Delta ED_t = (D_t - S_t) - (D_{t-1} - S_{t-1}) .$$

By rearranging terms on the right-hand side,

$$\Delta ED_t = (D_t - D_{t-1}) - (S_t - S_{t-1}) = \Delta D_t - \Delta S_t .$$

**If the given wage is less than the equilibrium wage, there will be excess demand in the market and the change in employment will reflect the shift in the supply curve. In this case, a positive value will not necessarily indicate an increase in excess demand, but will instead indicate a decrease in the reserve pool of teachers. This is because an actual shift in the supply curve greater than the change in population indicates an increase in the proportion of eligibles entering teaching. If individuals view the size of the reserve pool as a threat to their employment security, a smaller reserve pool will increase the individuals' perception of their future employment security. Since the relative employment probability can be interpreted as a measure of employment security, the direction of change in supply will still be the same.

teaching and alternative occupations. To control for scale differences we divided the relative changes by the level of employment in the two occupations.[*] This relative employment probability variable was entered separately with the implicit assumption that it reflected a nonmonetary reward, employment.[**]

Although individual preferences and tastes for wage relative to nonmonetary rewards are not directly measurable, they can be approximated using certain individual characteristics, such as race, sex, family income, etc., assuming such characteristics reflect an individual's hereditary and environmental background. Since our basic model, Eq. 15, aggregates all individuals within a state and estimates average proportions across individual states, the Z_i variables must reflect average differences in aggregated individual characteristics across states. One important characteristic is family income. While we can control for state differences in average income with the average per capita income in each state, the actual distribution of income is also important, but no data were available to describe the distribution of family income or the class structure within states. Consequently, we introduced dichotomous dummy variables for different regions of the country to indicate possible regional differences in social attitudes and class structure.

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[*] The relative employment probability was approximated as

$$\text{rep}_t = \frac{(\Delta T_t - \Delta E_t)\ \alpha A_t}{T_t\ (\alpha \Delta A_t - \Delta B_t)} ,$$

where ΔT_t = change in teacher employment between t-1 and t approximating change in demand,

ΔE_t = change in graduates eligible to teach approximating change in supply,

ΔA_t = change in alternative (movement and service industry) employment,

α = proportion in BAs in alternative work force,

ΔB_t = change in BA graduates, and

T_t and A_t = the level of t-year employment in teaching and the alternative occupation to adjust for scale differences.

[**] As an alternative for employment security, we also used the relative employment growth in the two occupations. This will be discussed more completely later.

We had data to measure directly some of the variables controlling for structural differences among states. Differences in state credentialing requirements and the degree of urbanization are the best examples. The best control for differences in state systems of higher education would have been the capacity of teacher-training institutes relative to the total capacity. We used actual enrollments to approximate capacity but, since enrollment in teacher-training institutes was not separately identified, we used the ratio of enrollment in private relative to public institutes of higher education. To measure differences in the structure of state labor markets, we used the number of teachers employed relative to total employment in the government and service industries of each state. The government and service industries were used to approximate alternative occupations to teaching because the proportion of the female work force with four or more years of college was highest there.*

EMPIRICAL RESULTS FROM CROSS-SECTION MODELS

The basic model depicted by Eq. 15 was estimated separately for three categories of eligible new graduates--females eligible for teaching elementary grades, females eligible for secondary, and males eligible for secondary. We did not make separate estimates for males eligible to teach elementary levels because of the limited size of this sample. In addition, California was excluded from all estimates because its requirement for an additional year beyond the BA for certification effectively eliminated all but a small residual percentage of new BA graduates from being eligible to teach.

Table 7 presents separate sets of estimates for the 1969 and 1970 groups of male and female BA graduates, respectively, eligible to teach secondary school. The variables used in the table are as follows:

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*Nationally, 21.1 percent of the women employed in the services and 12.1 percent of those in public administration had completed four or more years of college in 1970. Only 11.1 percent of the total female work force had completed four or more years of college.

Symbol Definition

rw_{t-2} = average secondary classroom teacher salary relative to average salary of alternative occupation (government workers);

Δrw_{t-2} = change in relative teacher wage, i.e., $(rw_{t-3} - rw_{t-2}) = \Delta rw_{t-2}$;

rep_{t-2} = proxy for relative employment probability, defined as the change in excess demand for teachers relative to government and service workers deflated by their respective employments;

NE = dichotomous dummy variable equal to 1 for eleven northeastern states;

RUR = continuous proxy variable for degree of ruralization, defined as the percentage of the state population in rural areas;

HE = continuous proxy for structural differences in state higher education systems, defined as enrollment in private relative to public institutions;

$CRED_{SEC}$ = number of professional educational hours required for teacher certification at secondary level;

S = dichotomous dummy variable for eight southern states;

NMIX = employment mix proxy variable for the extent of the labor market, defined as teacher employment relative to total government and services employment; and

PCY = average per capita income in each state.

It is obvious that many of our variables controlling for state structural differences and differences in aggregate population characteristics do not perform satisfactorily. The coefficients of many are never significantly different from zero statistically. For example, we expected a *negative* relationship between the proportion of graduates eligible to teach secondary school and the number of hours of professional education courses required for secondary certification, since the greater the number of course requirements, the more difficult it is to obtain a teaching certificate as a by-product of a liberal arts degree. We also expected to observe a negative relationship between mean per capita income and the proportions of graduates eligible to teach, since teaching has been a traditional means for upward mobility for the lower economic classes, as indicated by the larger percentages of college students from low-income classes selecting teaching as a prospective career. However, we obtained positive signs in three of the four cases for our credentialing requirement

Table 7

SIGNIFICANCE OF NONECONOMIC VARIABLES FOR BA GRADUATES ELIGIBLE TO TEACH SECONDARY SCHOOL (standard errors in parentheses)

Variables[a]	1969				1970			
	Female		Male		Female		Male	
DEP VAR[b]	p^{FS}	p^{FS}	p^{MS}	p^{MS}	p^{FS}	p^{FS}	p^{MS}	p^{MS}
MEAN	.274	.2740	.1752	.1752	.2670	.2670	.1684	.1684
CONSTANT	−.013	−.028	.103	.053	.087	.084	.108	−.048
INDEP VAR								
rw_{t-2}	.195	.182	.019	.049	.114	.085	.013	.040
	(.06)[c]	(.07)[c]	(.077)	(.094)	(.063)[d]	(.070)	(.067)	(.08)
Δrw_{t-2}	.021	.046	.055	.036	.052	.052	.064	.033
	(.10)	(.11)	(.133)	(.146)	(.14)	(.15)	(.151)	(.158)
rcp_{t-2}	−.0002	.00016	−.0021	.0013	−.00003	.00002	−.0001	−.0001
	(.001)	(.0012)	(.0013)	(.0017)	(.0002)	(.0002)	(.0002)	(.0002)
MF	−.052	−.0322	−.0502	−.0344	−.0604	−.0706	−.0454	−.0379
	(.016)[c]	(.0215)	(.021)[c]	(.029)	(.018)[c]	(.023)[c]	(.019)[c]	(.025)
RUR	.195	.149	.179	.185	.172	.176	.176	.210
	(.05)[c]	(.07)[c]	(.07)[c]	(.099)[d]	(.057)[c]	(.073)[c]	(.061)[c]	(.078)[c]
ME	−.013	−.012	−.009	−.0217	−.009	−.007	−.007	−.011
	(.005)[c]	(.005)[d]	(.006)	(.007)[d]	(.005)[d]	(.006)	(.005)	(.006)[d]
$CRED_{SEC}$	- - -	.0043	- - -	.0014	- - -	.0009	- - -	.0006
	- - -	(.0033)	- - -	(.0045)	- - -	(.004)	- - -	(.004)
S	- - -	.0062	- - -	.0117	- - -	.020	- - -	.011
	- - -	(.018)	- - -	(.024)	- - -	(.020)	- - -	(.022)
NMIX	- - -	.063	- - -	.151	- - -	−.114	- - -	.125
	- - -	(.12)	- - -	(.169)	- - -	(.116)	- - -	(.124)
PCY	- - -	−.00002	- - -	−.00001	- - -	.0002	- - -	.0002
	- - -	(.00002)	- - -	(.00003)	- - -	(.00002)	- - -	(.00002)
R^2(adj)[e]	.5687	.5815	.3818	.3556	.4618	.4642	.3409	.3272
F	11.4	7.32	5.81	3.36	8.04	4.84	5.0	3.05
SEE	.0455	.045	.059	.061	.0499	.051	.053	.055

[a] A glossary of variables appears on p. 66.

[b] Dependent Variable = $p^{F(M)S}$ = proportion of female (male) BAs eligible to teach secondary school.

[c] Coefficient is significantly different from zero at 2.5-percent level using one-tail test.

[d] Indicates coefficient significant at 5-percent level using one-tail test.

[e] Adjusted for degrees of freedom.

variable and in two of the four cases for our per capita income (PCY) variable, albeit none was significant at the 10-percent level. Likewise, our variable to reflect the relative size of the state's labor market for high-level manpower (college-educated labor) also was positive in three of the four cases. We expected a negative relationship inasmuch as a larger high-level manpower labor market would contain more alternative employment opportunities to teaching and, given the same distribution of abilities and preferences, we would expect proportionally fewer individuals to select teaching in those states where more alternative employment opportunities exist. Our dichotomous dummy variable for the southern states* had the expected positive sign but was never statistically significant.

As a group, these four variables added nothing to the explanatory power of our equation. In fact, in every case except for 1969 females, the addition of these four variables actually reduced the adjusted R^2 for our total regression.

The three remaining noneconomic variables have the expected sign and are statistically significant in the majority of cases. Thus in all eight cases depicted in Table 7, the proportion of BA graduates eligible to teach secondary school was higher the greater the degree of ruralization (i.e., the higher the proportion of the population in rural areas) within each state. As expected, the structure of higher education within each state also influenced the proportion of graduates eligible to teach. Our specific control variable, the ratio of private to public enrollment in higher education (HE), had the expected negative relationship, but surprisingly was not significant at the 5-percent level for males when the other insignificant noneconomic variables were excluded from the regression. Finally, our dichotomous dummy variable for the northeastern region** had the expected negative sign and was statistically significant at the 2.5-percent level, once the insignificant variables were excluded.

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*The eight southern states were: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, and South Carolina.

**The eleven northeastern states included: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

One major disappointment was the failure of the proxy variable for relative excess demand in the relevant labor markets to perform as we anticipated. In no case was the coefficient significantly different from zero, and in many instances we obtained a negative rather than a positive sign.* Subsequently, we substituted the relative growth in employment in the teaching and alternative occupations as the proxy variable to reflect relative employment security.

The adjusted R^2 shown in Table 7 is much larger in the equations for female than in the equations for male, which indicates the greater total explanatory power of the former. In both cases, however, the amount of state variation among state proportions of eligibles employed by the model is surprisingly large for a cross-sectional analysis, especially given the substantial data problems already discussed. The superior explanatory power of the equations for female is due principally to the greater significance of their relative wage rate variable. Thus, although all the relative wage terms have the expected positive signs, they are statistically significant only for females.

Importance of Economic Variables

Tables 8 through 12 show results from some of our empirical tests for females and males eligible to teach secondary levels and females eligible to teach elementary levels. Of the various expectations hypotheses tested, the one that worked best was the hypothesis that individuals adjust their initial expectation for observed changes in relative growth. Consequently, the tables show both the relative wage and the employment security** economic variables in level and first difference forms. Both versions of the basic model (Eq. 15) shown in these tables omit the insignificant structural control variables. The difference between the two equations is the presence of two first difference forms for the economic variables in Eq. 11 compared with the single first difference form in Eq. 10.

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*Although these results from Table 7 strictly apply only to the particular case where employment probability is considered distinctly separate from wages, we also tested the alternative hypotheses that relative employment prospects affected the expected wage return directly, and this also failed to produce a significant positive effect.

**This employment security variable is the relative employment growth that was substituted for our ineffective relative excess demand proxy variable.

Results for Females Eligible To Teach Secondary Grades

The estimated supply functions for females eligible to teach secondary grades shown in Tables 8 and 9 for the 1970 and 1969 groups provide several interesting observations. First, despite the poor quality of the basic data and the extensive use of proxy variables, the models explain about 60 percent of the interstate variations in the production of new female BAs qualified to teach secondary grades. Second, both the relative wage and employment security variables are predominantly positively related to the proportions of female BAs eligible to teach secondary grades. Moreover, when the relationship is statistically significant, there is always a positive relationship except for the level, relative employment security variable in the two-year lag model (Eq. 10) for the 1970 group (Table 8).* These two observations provide strong support for the conclusion that the supply of newly qualified teachers has a lagged response to economic conditions in the teacher labor market relative to alternative markets.

A third interesting result is the tendency of the economic variables to increase in importance with the length of the lag used. For example, the coefficients of the economic variables are substantially larger for the 1970 group equation with a three-year lag relative to the two-year lag. The same is true for the 1969 females (Table 9), with the coefficient for the level of relative employment security being the principal exception. There is no similar pattern for the difference in the size of the economic variables' coefficients between the three- and four-year lag models, however, as indicated in Table 8.

A final interesting observation is the predominance of negative coefficients for the interaction terms between the degree of ruralization and the employment security proxy variables. Moreover, in the majority

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*The overall results for this particular equation are also much poorer relative to the other models tested; for example, the adjusted R^2 is only .5580.

Table 8

ESTIMATED SUPPLY FUNCTIONS RESULTS FOR 1970 FEMALES ELIGIBLE FOR SECONDARY[a]
(standard errors in parentheses)

	Two-year Lag	Three-year Lag		Four-year Lag	
Variables[b]	Eq. 1	Eq. 1	Eq. 2	Eq. 1	Eq. 2
NE	-.060 (.017)[c]	-.056 (.015)[c]	-.054 (.017)[c]	-.052 (.017)[c]	-.044 (.019)[c]
RUR	.181 (.053)[c]	.325 (.079)[c]	.323 (.085)[c]	.310 (.070)[c]	.357 (.095)[c]
HE	-.007 (.005)	-.006 (.004)	-.006 (.005)	-.006 (.005)	-.006 (.005)
rw_{b-n}	.097 (.058)	.103 (.054)[d]	.102 (.059)[d]	.117 (.058)[c]	.096 (.06)
rep_{t-n}	-.371 (.145)[c]	1.245 (.416)[c]	1.263 (.442)[c]	.834 (.62)	1.073 (.69)
Δrw_{t-n}	-.061 (.110)	.115 (.105)	.124 (.152)	.069 (.096)	.101 (.98)
Δrep_{t-n}	-.009 (.069)	.252 (.282)	.257 (.296)	.985 (.341)[d]	1.26 (.42)[c]
Δrw_{t-n+1}	---	---	.004 (.133)	---	.077 (.11)
Δrep_{t-n+1}	---	---	-.030 (.068)	---	.380 (.31)
$RUR \cdot rep_{t-n}$	.982 (.327)[c]	-3.248 (.967)[c]	-3.293 (1.02)[c]	-2.64 (1.46)[d]	-3.47 (1.69)[c]
$RUR \cdot \Delta rep_{t-n}$	.301 (1.63)	-.667 (.721)	-.695 (.76)	-2.72 (.71)[c]	-3.52 (1.02)[c]
$RUR \cdot \Delta rep_{t-n+1}$	---	---	.067 (.161)	---	-.89 (.77)
CONST	.102	.042	.044	.037	.043
R^2[e]	.5580	.6161	.5988	.6047	.6113
F	7.45	9.27	6.48	8.87	6.79
SEE	.0460	.0429	.0444	.0435	.0437

[a] Mean Dep Var = P_{70}^{FS} = .2670.

[b] A glossary of variables appears on p. 66.

[c] Significant at .05 level, two-tail test.

[d] Significant at .10 level, two-tail test.

[e] Adjusted for degrees of freedom.

Table 9

ESTIMATED SUPPLY FUNCTIONS RESULTS FOR 1969 FEMALES ELIGIBLE FOR SECONDARY[a]
(standard errors in parentheses)

Variables[b]	Two-year Lag		Three-year Lag	
	Eq. 1	Eq. 2	Eq. 1	Eq. 2
NE	-.0[illegible]1 (.015)[c]	-.052 (.017)[c]	-.046 (.017)[c]	-.043 (.020)[c]
RUR	.293 (.060)[c]	.313 (.084)[c]	.242 (.07)[c]	.278 (.10)[c]
HE	.010 (.004)[c]	-.008 (.005)[d]	-.012 (.005)[c]	-.011 (.005)[c]
rw_{t-n}	.188 (.055)[c]	.176 (.058)[c]	.190 (.058)[c]	.177 (.061)[c]
reo_{t-n}	.777 (.418)[d]	.669 (.436)	.039 (.62)	.342 (.70)
Δrw_{t-n+1}	---	-.117 (.131)	---	.109 (.115)
Δrep_{t-n+1}	---	.688 (.673)	---	.268 (.316)
$RUR \cdot rep_{t-n}$	-.203 (.97)[c]	-1.815 (1.01)[d]	-.518 (1.5)	-1.30 (1.71)
$RUR \cdot \Delta rep_{t-n}$	-.578 (.724)	-.413 (.751)	-1.47 (.71)[c]	-2.10 (1.04)[c]
$RUR \cdot \Delta rep_{t-n+1}$	---	-.149 (1.59)	---	-.716 (.778)
CONST	.309	-.032	-.019	-.017
R^2 [e]	.6209	.6177	.6101	.6122
F	9.45	6.96	9.06	6.82
SEE	.0431	.6439	.0437	.0442

[a] Mean Dep Var = P^{FS}_{69} = .2740.

[b] A glossary of variables appears on p. 66.

[c] Significant at .05 level, two-tail test.

[d] Significant at .10 level, two-tail test.

[e] Adjusted for degrees of freedom.

of cases, these coefficients are statistically significant. The implication of this result is that females in heavily rural states are less responsive to changes in teacher labor market conditions than those in more urban states. This may reflect either the lack of sufficient alternative opportunities in rural areas or an inadequate information system in these rural states such that information on the "true" conditions of relative labor markets is not conveyed to students making their career decisions in these states.

Results for Males Eligible To Teach Secondary Grades

The estimates for the supply of new male graduates eligible to teach secondary grades (Tables 10 and 11) are less accurate than those for female graduates eligible to teach secondary. The adjusted R^2 are substantially smaller (a range from .46 to .34 versus .62 to .56), thus indicating that the two forms of our basic model (questions 1 and 2) explains a smaller proportion of the interstate variation of new graduates eligible to teach secondary grades for males than for females. Moreover, there are fewer significant independent variables in our equations for males compared with those for females.

The most significant difference between our results for males and females eligible to teach secondary grades is the failure of the relative wage term to perform in the equations for males. There are two explanations for this. First, married females may have the option of nonlabor force activity while males do not. Consequently, females may behave more like secondary workers in the labor forces and adjust their participation rate to relative wage offers. Males, on the other hand, may be more risk-averse and thus more responsive to relative job opportunities than to potential relative income (i.e., wage rate) differences when the employment probabilities for the higher paying career are substantially smaller than for the alternative career choices.

It is also likely, however, that the relative wage term we have used is inappropriate for males. If it is true that males tend to view teaching positions strictly as a means of obtaining an administrative position within education rather than as a permanent career, this appropriate male

Table 10

ESTIMATED SUPPLY FUNCTIONS RESULTS FOR 1970 MALES ELIGIBLE FOR SECONDARY[a]

(standard errors in parentheses)

	Two-year Lag	Three-year Lag		Four-year Lag	
Variables[b]	Eq. 1	Eq. 1	Eq. 2	Eq. 1	Eq. 2
NE	-.038 (.020)^{c}	-.043 (.019)^{d}	-.036 (.020)^{c}	-.036 (.021)^{c}	-.019 (.023)
RUR	.260 (.090)^{d}	.314 (.096)^{d}	.330 (.103)^{d}	.230 (.084)^{d}	.326 (.114)^{d}
HE	-.006 (.005)	-.005 (.005)	-.003 (.006)	-.006 (.005)	-.006 (.006)
rw_{t-n}	.003 (.065)	.020 (.066)	.001 (.070)	.006 (.069)	-.018 (.071)
rep_{t-n}	.373 (.358)	1.043 (.507)^{d}	.966 (.533)^{c}	.323 (.748)	.663 (.823)
Δrw_{t-n}	-.108 (.129)	.042 (.127)	-.063 (.184)	.081 (.116)	.121 (.117)
Δrep_{t-n}	-.027 (.080)	.385 (.349)	.351 (.357)	.624 (.410)	1.115 (.508)^{c}
Δrw_{t-n+1}	---	---	-.142 (.160)	---	.014 (.135)
Δrep_{t-n+1}	---	---	-.023 (.082)	---	.636 (.372)^{c}
RUR · rep_{t-n}	-.940 (.920)	-2.535 (1.18)^{d}	-2.397 (1.23)^{d}	-1.194 (1.76)	-2.556 (2.01)
RUR · Δrep_{t-n}	.085 (.191)	-1.008 (.878)	-.894 (.918)	-1.576 (.85)^{c}	-2.934 (1.22)^{d}
RUR · Δrep_{t-n+1}	---	---	.072 (.194)	---	-1.468 (.917)
CONST	.087	.045	.062	.098	.091
R^{2} [e]	.3376	.3762	.3620	.3741	.3976
F	3.47	3.96	2.91	3.93	3.27
SEE	.0539	.0522	.0536	.0523	.0521

[a] Mean Dep Var = $\bar{P}^{MS}_{70}$ = .1684.

[b] A glossary of variables appears on p. 66.

[c] Significant at .10 level, two-tail test.

[d] Significant at .05 level, two-tail test.

[e] Adjusted for degrees of freedom.

Table 11

ESTIMATED SUPPLY FUNCTIONS RESULTS FOR 1969 MALES ELIGIBLE FOR SECONDARY[a]
(standard errors in parentheses)

Variables[b]	Two-year Lag		Three-year Lag	
	Eq. 1	Eq. 2	Eq. 1	Eq. 2
NE	-.043 (.021)[c]	-.034 (.022)	-.039 (.023)[d]	-.022 (.026)
RUR	.407 (.107)	.428 (.108)[c]	.284 (.096)[c]	.414 (.127)[c]
HE	.005 (.006)	-.001 (.007)	-.007 (.006)	-.006 (.006)
rw_{t-n}	.018 (.073)	-.012 (.075)	.008 (.080)	-.021 (.080)
reo_{t-n}	1.334 (.559)[c]	1.140 (.562)[c]	.442 (.852)	1.073 (.920)
Δrw_{t-n}	.106 (.140)	-.102 (.194)	.074 (.132)	.131 (.131)
Δrep_{t-n}	.603 (.379)	.550 (.377)	.725 (.467)	1.399 (.567)[c]
Δrw_{t-n+1}	---	-.267 (.169)	---	.093 (.151)
Δrep_{t-n+1}	---	.024 (.087)	---	.823 (.416)[c]
$RUR \cdot rep_{t-n}$	-3.444 (1.30)[c]	-2.968 (1.30)[c]	-1.534 (2.00)	-3.575 (2.25)
$RUR \cdot \Delta rep_{t-n}$	-1.609 (.918)	-1.306 (.968)	-1.921 (.968)[c]	-3.785 (1.36)[c]
$RUR \cdot \Delta rep_{t-n+1}$	---	.041 (.204)	---	-2.023 (1.02)[c]
CONST	.023	.046	.084	.071
R^2 [d]	.4284	.4638	.3872	.4327
F	4.73	4.06	4.11	3.66
SEE	.0576	.0565	.0596	.0581

[a] Mean Dep Var = $\bar{P}^{MS}_{69}$ = .1752.

[b] A glossary of variables appears on p. 66.

[c] Significant at .05 level, two-tail test.

[d] Adjusted for degrees of freedom.

wage would be an average of teacher salary plus administrative salaries. This explanation also helps explain the greater importance for males of the relative employment growth term, since expanding school districts are more likely to require additional administrators than stable or declining ones.

Results for Females Eligible To Teach Elementary Grades

Our results for females eligible to teach elementary grades are shown in Table 12. There are only six significant relationships between the economic variables included in our model and the proportion of female BA graduates eligible to teach elementary grades. Of these six relationships, five involve the relative wage and only one the relative employment opportunity variable. Hence if females considering elementary teaching are at all responsive to relative labor market conditions, these results would suggest they are more sensitive to relative income levels than employment opportunities.

LENGTH OF LAG

The length of the delay between the time of selecting a teacher preparatory program and the time of entry into the market (i.e., the long-run supply lag) is particularly important for educational manpower decisionmakers. To determine the length of the long-run supply lag, we estimate Eqs. 10 and 11 using different lag structures ranging from two to four years. We use some statistical criteria to compare these different results and thus establish which lag structure is most appropriate. Our criteria for each result are

1. "Goodness of fit" reflected in the adjusted R^2,
2. Standard error of estimate,
3. Number of significant independent variables, and
4. Stability of the coefficients over time when two annual estimates are available.

Table 12

ESTIMATED SUPPLY FUNCTIONS FOR NEW GRADUATES RESULTS FOR FEMALES ELIGIBLE FOR ELEMENTARY[a]

(standard errors in parentheses)

Variables[b]	1969 Group		1970 Group	
	Three-year Lag	Two-year Lag	Four-year Lag	Three-year Lag
MEAN	.2883	.2883	.2856	.2856
INDEP VAR				
NE	-.026 (.018)	-.033 (.016)[c]	-.024 (.019)	-.028 (.016)[d]
RUR	.952 (.458)[c]	1.079 (.402)[c]	.527 (.491)	.494 (.020)
ME	-.020 (.005)	-.020[d] (.004)	-.0163 (.005)	-.0177 (.004)[c]
rw_{t-n}	.220 (.153)	.287 (.142)[c]	-.015 (.16)	.008 (.149)
rep_{t-n}	-.103 (.703)	-.034 (.366)	.833 (.75)	-.068 (.38)
Δrw_{t-n}	.389 (.217)[d]	-.119 (.247)	.252 (.233)	.117 (.259)
Δrep_{t-n}	.183 (.387)	-.070 (.233)	.449 (.41)	-.380 (.243)
$RUR \cdot rw_{t-n}$	-.849 (.404)[c]	-1.012 (.357)[c]	-3.97 (.43)	-.498 (.373)
$RUR \cdot \Delta rw_{t-n}$	-1.434[c] (.663)[c]	.611 (.931)	-1.22 (.71)	.184 (.687)
$RUR \cdot rep_{t-n}$	-.765 (1.66)	-.497 (.911)	-2.584 (1.77)[d]	-.343 (.95)
$RUR \cdot \Delta rep_{t-n}$	-1.[illegible]78 (1.[illegible]2)	.216 (.585)	-1.562 (1.1)	.793 (.612)
CONST	.070	.004	.295	.321
R^2 (adj.)[e]	.4979	.5096	.3855	.4267
F	4.95	5.16	3.40	3.9
SEE	.0402	.0397	.0430	.0415

[a] Dep Var = P^{FE} = proportion of female BA graduates eligible to teach elementary grades.

[b] A glossary of variables appears on p. 66.

[c] Coefficient significant at .025 level for one-tail test.

[d] Coefficient significant at .05 level for one-tail test.

[e] Adjusted for degree of freedom.

Results for Females Eligible to Teach Secondary Grades

For the 1970 females (Table 8), the two-year lag model is inferior to both the three- and four-year lag models by each of the first three criteria. There is little difference between the three- and four-year lag models. On the one hand, the three-year lag model has a larger R^2, a lower standard error of estimate, but one less significant independent variable than the four-year lag model. On the other hand, the four-year model has a higher R^2, a lower standard error, and an equal number of significant variables as the three-year lag model. For the 1969 females (Table 9), the first three criteria indicate no substantial difference between the two- and three-year lag models. However, the coefficients of the two-year model are substantially more unstable over time than are those for the three-year model. Indeed, the coefficient for rep_{t-n} for the two-year lag model changes from *positive* for the 1969 group to *negative significant* for the 1970 group. Although the evidence is not overwhelming, it supports the presence of a three- or four-year lag in the long-run supply of new female secondary teachers.

Results for Males Eligible to Teach Secondary Grades

Our conclusions about the appropriate length of the long-run supply lag are more ambivalent for males than for females, however. An analysis of results, shown in Table 11, indicates that the two-year lag model has a lower adjusted R^2, a larger standard error of estimate, and fewer statistically significant independent variables than either the three- or four-year lag model. The three- and four-year lag models perform equally well for the 1970 group, given our evaluation criteria.

These conclusions are reversed, however, when the models are applied to the 1969 group. In this case, the two-year lag model surpasses the three-year lag model by having a higher adjusted R^2 and a smaller standard error of estimate. The two-year lag model has more significant independent variables than the three-year lag model. Again, the evidence is not overwhelming, but these results do indicate the presence of a two-to-four-year lag in the long-run supply of new male graduates eligible to teach secondary grades.*

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*Results from our stability analysis described below, however, suggest that a three-to-four-year lag may be the most accurate.

PREDICTIVE ABILITY

A critical concern at this point is whether the lagged supply model as currently developed can be used to project the supply of new female secondary teachers at either the national or state level. The answer to this depends upon (1) the stability of the estimated cross section coefficients over time and (2) the size of the obtained residuals for particular observations (in this case, states).

Results for Females Eligible To Teach Secondary Grades

The coefficients obtained for the three-year lag model for females eligible to teach secondary grades are consistent for the two annual estimates shown in Tables 8 and 9. The only changes in signs occur in Eq. 11 for the Δrep_{t-n+1} and the interactive RUR $\cdot$ Δrep_{t-n+1} variables, but none of the coefficients are significantly different from zero statistically. However, stability requires not only consistency in sign, but also consistency in relative size. For this criterion the results are mixed. A number of the statistically significant 1969 coefficients are within one standard error of their respective 1970 coefficients. Examples of this are the coefficients for the northeast and rural structural control variables and the coefficients for the Δrw_{t-n} variables. On the other hand, there are some substantial changes in the magnitude of some of the significant coefficients, particularly the coefficients for the higher education control variable, the relative wage variable (rw_{t-n}), the relative employment opportunity variable (rep_{t-n}), and the Δrep_{t-n} variable and the interaction variables, RUR $\cdot$ rep_{t-n} and RUR $\cdot$ Δrep_{t-n}.

Although most of the economic variable coefficients undergo substantial size changes between 1969 and 1970, there is an interesting pattern in many of the changes. For example, all the coefficients for the relative wage variable decrease in size between 1969 and 1970, while the coefficient for the level of relative employment opportunity quadruples in size between 1969 and 1970. If wages are indeed established independent of labor market conditions, and if a dramatic change in those labor market conditions from shortage to surplus began to emerge during the late 1960s, one would expect individuals to become less responsive to wage levels, and more responsive to employment opportunities, which are becoming increasingly rare.

On balance, the coefficients in the two equations for the three-year lag model are consistent and moderately stable over time. Hence the model may prove useful in making average national projections, assuming that the distribution of teacher production among the states does not change radically during the projection period.[*] It is unlikely that the model can be used to project individual state production. A major reason for this is shown in Tables 14 and 15, which present an analysis of the residuals from the three-year lag equations for the 1969 and 1970 groups. The dichotomy between accurate and inaccurate state predictions is arbitrary, based on the size of the residual relative to the actual value. The model provides an accurate state prediction if the residual is less than 5 percent of the actual value. If the residual is greater than 20 percent of the actual value, the model provides an inaccurate state prediction. For each accurate and inaccurate state prediction, the size and sign of the error relative to the actual value is shown for all four equations.

Three basic points can be made from this analysis of the residuals. First, although the model fits a number of state situations well under some circumstances, and conversely, does poorly under similar circumstances for other, albeit fewer states, there is little substantial consistency across all four equations. In fact, the model predicts consistently[**] well for only five states--the District of Columbia, Kansas, Michigan, Montana, and Oregon--and consistently poorly for only four states--Hawaii, Texas, Utah, and Wisconsin. Second, there is no single characteristic which differentiates the states for which the model performs particularly well (or poorly) as a group from the remaining states. Finally, there is no fundamental tendency among the residual states toward either over or under prediction.

Although the model predicts consistently poorly for only four states, the general inconsistency of the model and the presence of

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[*] This assumption is necessary because we have not used weighted regression estimates. Detailed discussion on this appears in Appendix A.

[**] The model provides consistent results if at least three of the four residuals are uniformly accurate or inaccurate.

Table 14

ANALYSIS OF ACCURATE[a] RESIDUALS[b] FROM EQUATIONS FOR FEMALES ELIGIBLE TO TEACH SECONDARY GRADES, THREE-YEAR LAG MODEL

(Residual/Actual)

States[c]	1970 Group		1969 Group	
	Eq. 1	Eq. 2	Eq. 1	Eq. 2
Alaska	---	---	.0006/2655	-.0031/.2655
Arkansas	.0133/.3878	.0157/.3878	---	---
Connecticut	---	---	---	-.0071/.1963
Delaware	.0126/.2621	.0093/.2621	---	---
D.C.	-.0014/.1069	.0019/.1069	.0026/.0648	.0021/.2938
Georgia	---	---	-.0082/.2938	-.0102/.2938
Indiana	.0146/.3101	---	---	---
Kansas	.0116/.2832	---	.0105/.2929	-.0073/.2929
Louisiana	---	---	---	---
Maryland	- .001/.2108	-.0033/.2108	---	---
Massachusetts	-.0065/.1718	-.0064/.1718	---	---
Michigan	-.0098/.2996	-.0114/.2996	.0077/.2709	---
Missouri	---	---	-.0092/.2715	-.0004/.2715
Montana	- .004/.3065	-.0056/.3065	.0006/.3078	-.0022/.3078
Nebraska	---	---	.0099/.2887	.0143/.2887
New Hampshire	---	---	.0017/.2169	-.0008/.2169
New York	.007/.1816	.0051/.1816	---	---
North Carolina	---	---	-.0114/.3224	---
Ohio	-.0054/.2606	-.0053/.2606	---	---
Oklahoma	---	---	.0044/.3132	-.0085/.3132
Oregon	.009/.2746	.0094/.2746	---	-.0113/.2550
Pennsylvania	---	---	---	.0077/.2379
South Dakota	---	---	---	.0082/.3418
Washington	---	---	.0079/.2573	- .003/.2573
West Virginia	-.0164/.3623	-.0165/.3623	---	---
Wyoming	.0138/.3008	.0138/.3008	---	---

[a] Accurate = residual less than .05 actual value.

[b] Residual = actual - predicted: negative residual thus implies overestimate.

[c] Underscore indicates states for which the model was able to predict consistently well.

Table 15

ANALYSIS OF INACCURATE[a] RESIDUALS[b] FROM EQUATIONS FOR FEMALES ELIGIBLE TO TEACH SECONDARY GRADES, THREE-YEAR LAG MODEL

(Residual/Actual)

States[c]	1970 Group		1969 Group	
	Eq. 1	Eq. 2	Eq. 1	Eq. 2
Arizona	---	.0442/.2068	---	---
Colorado	---	---	-.0572/.2005	-.0453/.2005
Florida	---	---	---	-.0531/.2607
Hawaii	- .611/.1457	-.0615/.1457	-.0995/.1078	-.0877/.1078
Idaho	-.0548/.2314	---	---	---
Indiana	---	---	-.0565/.2757	---
Maine	-.0503/.2325	-.0511/.2325	---	---
Minnesota	-.0509/.2297	-.0515/.2297	---	---
New Jersey	.0576/.2635	.0543/.2635	---	---
New Mexico	-.1125/.1612	-.1118/.1612	---	---
Ohio	---	---	-.0517/.2404	-.0492/.2404
Texas	.0644/.2935	.0634/.2935	---	.0628/.2930
Utah	.0563/.2757	.0575/.2757	.0943/.3192	. 097/.3192
Vermont	-.0240/.0964	-.0234/.0964	---	---
Washington	.0933/.3516	.0929/.3516	---	---
Wisconsin	-.0535/.2225	-.0535/.2225	-.0542/.2305	-.0488/.2305
Wyoming	---	---	.0770/.3760	.0812/.3760

[a] Inaccurate = residual greater than .20 actual value.

[b] Residual = actual - predicted: negative residual thus implies overestimate.

[c] Underscore indicates states for which the model was able to predict consistently well.

substantial prediction problems for some states under different circumstances strongly suggest caution in using the model, as currently developed, for individual state predictions. More reliable and complete data might improve the performance of the model, and would certainly eliminate the gross inconsistency of predicting well for one year and one equation, but poorly the following year.[*]

Results for Males Eligible To Teach Secondary Grades

When we compare the stability of the coefficients for the two- and three-year lag models, the three-year model appears to be more stable. For the two-year lag model, three of the four significant coefficients, those for RUR, rep_{t-n}, and RUR · rep_{t-n}, differ by more than one standard error. For the three-year lag model, however, only one of the five significant coefficients--the coefficient for rep_{t-n}--differs by more than one standard error. Although the evidence for males is not as conclusive as that for females, the long-run supply lag for males appears to be about three to four years in length.

The predictive accuracy of the supply models for males is also lower than that for females. Consistently accurate residuals[**] are obtained for the three-year lag model estimated for both the 1969 and 1970 groups for only 5 of the 50 states used in the analysis; consistently inaccurate residuals occur for 16 of the 50 states. These states are identified in Table 16. A major reason for this poor fit is the presence of five extreme outlier states. These states all had between 29 and 42 percent of the 1969 BA male graduates eligible to teach, while the national average was only 17.5 percent. Inserting a dummy variable in the three-year lag model for the 1969 group, for these states--Kentucky, Mississippi, Montana, North Dakota, and South Dakota--increased the adjusted R^2 from .3741 to .7433, reduced the standard error of estimate from .0523 to .0392, decreased the number

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[*] Data errors seem to be largely responsible for these inconsistencies. For example, Washington's proportion changes from .2573 in 1969 to .3516 in 1970--a change too large to be reasonable over a one-year period.

[**] Consistently accurate residuals occur when any one state's residual is less than .05 of the actual value in at least two of the four equations (Eqs. 10 and 11 for both 1969 and 1970 groups) tested. Inaccurate residuals are similarly defined when the residual is greater than .20 of the actual value.

Table 16

CONSISTENTLY ACCURATE AND INACCURATE RESIDUALS FROM THREE-YEAR LAG MODELS FOR 1969 AND 1970 GROUPS

States with Accurate Residuals	States with Inaccurate Residuals	
Arkansas	Alaska	Montana
Colorado	Delaware	Nebraska
Indiana	Georgia	North Carolina
Iowa	Hawaii	North Dakota
Vermont	Illinois	Rhode Island
	Kentucky	South Carolina
	Louisiana	South Dakota
	Mississippi	Virginia

of inaccurate residuals for this particular equation from 23 to 14 states, and increased the number of accurate residuals from 6 to 10 states.

SUMMARY

Although the strength and consistency of our results vary considerably among the types of eligible new teachers, there are positive, significant relationships between the number of new BAs qualified to teach and the prevailing relative teacher wage and the relative teaching employment opportunity in each state. Hence conditions in the teacher labor market do influence teaching career choices and thus affect the potential supply of teachers. Our results also indicated a substantial long-run supply lag—in the case of females eligible for secondary school teaching a three- to four-year lag.

As currently developed, some of the models could be used to make average national projections of the supply of new graduates eligible to teach. Current data inadequacies, however, limit the usefulness of such projections. More complete data on the number of new graduates eligible to teach by state, the average starting salaries in teaching and alternative careers, and the relative employment probabilities for teaching and alternative careers should improve the aggregate accuracy of the models, and perhaps permit further disaggregating of the models to obtain individual state estimates.

VI. CONCLUSIONS AND IMPLICATIONS

THE TEACHER PRODUCTION RATE

Previous studies have assumed that the annual teacher production rate--the proportion of new college graduates who are qualified to teach--is stable over time. Our examination of the NEA data on annual teacher production showed that this assumption is invalid. *The annual rates at which new college graduates have been prepared to teach have consistently declined for at least seven years.*[*] By 1972, total teacher production had fallen to about 88 percent of the number of new teachers who would have been produced had 1966 production rates been maintained.

Our theoretical analysis of career choice showed that the relative availability of teaching positions in any given year should have a significant influence on the proportion of new college graduates three or four years later who have prepared to teach. The empirical analysis of the career choice model verified this hypothesis. The interpretation of these results is that college freshmen and sophomores take account of the probability that they will be able to enter a teaching career in deciding whether or not they will enter a teacher-preparation program.

The responses to the annual ACE surveys of entering college freshmen reinforce this view. They show that, since 1968, the rates at which entering freshmen intend to pursue a teaching career have consistently declined. Further, as the magnitude of the surplus increased, the rate of decline in interest in teaching among entering college freshmen has accelerated.[**]

These results clearly imply that the annual teacher production rate, which has consistently declined over the past seven years, is likely to continue to decline.

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[*] The decline may have begun before 1966, but available data do not permit extension of our analysis to prior years.

[**] The percentage declines on the rates at which entering college freshmen intended to pursue a career in teaching were, for males, 14 percent (between 1968 and 1969), 11 percent (1969 to 1970), 22 percent (1970 to 1971), and 24 percent (1971 to 1972). Comparable rates of decline for females were, respectively, 3 percent, 15 percent, 20 percent, and 21 percent.

While the likely future trend in the annual teacher production rate is apparent, the magnitudes of the declines in the annual proportion of new college graduates who are qualified to teach cannot be predicted with any precision. The available data only extend through the class of 1972. Consequently, we have yet to observe the rate of teacher production among students who entered college after the teacher surplus emerged, and we do not have data on the extent to which the career choices expressed by entering college freshmen are reflected in their college curricula.

THE SUPPLY OF NEW TEACHERS

To explore the possible implications of continued decline in the proportion of new college graduates who are qualified to teach, we projected teacher production rates through 1981 under a variety of alternative assumptions. The results of this exercise are discussed below.

Alternative Projections

The supply of new teachers in any year is defined as the number of new college graduates qualified to teach who seek teaching positions in that year. Three elements thus enter the projection of new teacher supply--the size of the BA degree class, the proportion of new graduates who are prepared to teach, and the proportion of eligible new graduates who seek positions in the education sector. Table 17 presents seven alternative projections of the annual supplies of new teachers that reflect different assumptions regarding the likely future values of each of the three elements.

It appears that the available projections of the annual sizes of future BA classes are overestimates.* However, an analysis of the determinants of college entrance and completion was beyond the scope of this study. Hence we use the most recent NCES (1973) projections of the annual BA classes in the first five sets of projections. The sixth and

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*Watkins (1973) points out that the available projections of college enrollments appear to overestimate total enrollments by 10 to 15 percent.

Table 17

ALTERNATIVE PROJECTIONS OF THE SUPPLIES OF NEW TEACHERS
(in thousands)

Year	Projections						
	1	2	3	4	5	6	7
1973	233.4	203.8	201.0	169.7	159.0	190.9	152.8
1974	241.5	211.7	204.5	147.0	129.0	194.3	132.2
1975	238.9	210.7	199.2	122.0	100.4	189.2	109.8
1976	252.7	223.4	206.5	107.9	83.4	196.2	97.1
1977	265.8	235.2	212.6	94.9	69.0	191.3	80.7
1978	278.9	247.3	218.4	83.3	57.0	196.6	70.8
1979	292.0	259.4	223.6	73.1	47.2	201.2	62.1
1980	300.4	266.9	224.6	63.0	38.4	202.1	53.6
1981	307.7	273.8	224.7	54.1	31.2	202.2	46.0

seventh sets of projections in Table 17 indicate the possible impact of overestimating the sizes of the annual BA degree class. We assume, in both cases, that the BA degree classes will be 5 percent smaller than projected through 1976 and 10 percent smaller thereafter.

We assume, in all seven cases, that 81 percent of the new graduates qualified to teach at the elementary level seek teaching positions and that 65.1 percent of the new graduates qualified to teach at the secondary level seek teaching positions. These are the mean annual rates at which new graduates qualified to teach at each level entered teaching positions during the 1952 through 1968 period according to the NEA (1972). Assuming that, in those years, virtually all qualified professionals who sought teaching positions were successful, these are the rates at which eligible new graduates have, in the past, sought teaching positions.

Previous studies have assumed that the annual teacher production rate--the proportion of new BA graduates who are qualified to teach--will be a constant equal to about .35. The first set of projections reflects this assumption.

The second set of projections assumes that the 1972 sex-specific production rates at the elementary and secondary levels (Table 5) will be maintained through 1981. That is, we assume that the declines in teacher production rates through 1972 abruptly cease and thereafter remain constant.

The third and sixth sets of projections are based on the assumption that the downward trends in teacher production rates are continued through 1981. For each sex at each level we regressed the annual teacher production rate (Table 5) on time and then extrapolated the regression line to future years to obtain projections of future production rates by sex and level.[*] In short, the third set of projections indicates what the annual supplies of new teachers will be if current trends in the NCES projections of the annual BA degree classes are accurate. The sixth set of projections indicates the annual new supplies if current trends in the production rates continue, but the annual sizes of the BA degree classes prove to be smaller than projected.

The fourth and seventh sets of projections represent attempts to take account of the recent sharp declines in the rates at which entering college freshmen intend to pursue a career in teaching. For each of the four groups (males and females interested in teaching at the elementary or secondary level) we computed the average annual rate of decline in interest in a teaching career, as reported by the ACE

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[*] Coding t as 1 for 1966 and so on through 1972 (t = 7) we obtained the following regression results:

$$\begin{array}{llll}
P_t^{ME} = .025 - & .0003t & \qquad & R^2 = .84 \\
 & (-5.20) & & \\
P_t^{MS} = .163 - & .0023t & \qquad & R^2 = .60 \\
 & (-2.71) & & \\
P_t^{FE} = .289 - & .0052t & \qquad & R^2 = .89 \\
 & (-6.44) & & \\
P_t^{FS} = .269 - & .0057t & \qquad & R^2 = .93\ , \\
 & (-8.40) & &
\end{array}$$

where P_t^{ME} = the proportion of male BA recipients prepared to teach at the elementary level in year t, and P_t^{MS} (P_t^{FE}, P_t^{FS}) is the proportion of male (female) BA recipients prepared to teach at the secondary (elementary) level.

(Table 6), between 1968 and 1972.[*] We then assumed that each sex-level specific teacher production rate would decline from its 1972 level at the rate of decline in interest in teaching at that level by the entering freshmen of that sex. In essence, we assume that whatever has been the relationship between the proportion of entering male (female) freshmen intending to pursue a career in teaching at the elementary (secondary) level and the proportion of male (female) college graduates four years later who are qualified to teach at the elementary (secondary) level, that relationship will be continued into the future.[**] The difference between the fourth and seventh sets of projections thus reflects the different assumptions regarding the sizes of the annual BA degree classes.

The fifth set of projections is computed in essentially the same manner as was the fourth set. However, the fifth set uses the annual average rates of decline in entering freshmen interest in teaching for the period from 1970 to 1972. These projections thus reflect the acceleration in the decline of freshmen intentions to pursue a teaching career.[†]

As noted earlier, the sixth and seventh sets of projections are based upon the teacher production rates assumed in the third and fourth sets of projections, respectively, but differ from them in the assumed numbers of BA degrees granted each year.

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[*] For example, the proportions of female entering freshmen interested in a teaching career at the secondary level were .181 in 1968 and .084 in 1972. The annual average rate of decline in interest in teaching at secondary level among females was thus .175; i.e., $.84 = .181\ (.825)^4$. We project the production rate for female, secondary in year t as .227 (the production rate for female, secondary in 1972) multiplied by $(.825)^{t-1972}$. Annual average rates of decline for male elementary and secondary and female elementary were .126, .188, and .130, respectively.

[**] This is equivalent to assuming that the rates at which students change between teacher preparation and alternative curricula and the rates at which students drop out of college will remain constant.

[†] For the 1970 to 1972 period, the annual average rates of decline for males (females) intending to pursue a career at the elementary level was .118 (.182). The proportion of entering male (female) freshmen intending to pursue a secondary level teaching career declined at an annual average rate of .242 (.236) during that period.

Discussion of the Projections

The wide variance among the first five sets of projections in Table 17 is attributable to the impact of the alternative assumptions regarding the future values of the teacher production rate. In view of the earlier analysis of trends in the teacher production rate, the first two sets of projections, which assume constant teacher production rates, appear grossly to overestimate the likely future supplies of new teachers. Since the first set of projections is conceptually equivalent to the projections of new teacher supply used in the previous studies, *we conclude that they have grossly overprojected the likely future supplies of new teachers. Consequently, their projections of the total supplies of teachers and of the sizes of the teacher surplus are overestimated.*

The third set of projections reflects the downward trends in teacher production rates obtained over the 1966 to 1972 period. In the absence of evidence to the contrary it would be reasonable to extrapolate these trends into the future. However, the ACE data (Table 6) and our results regarding the relationship between the relative availability of teaching positions in one year and the teacher production rate three or four years later suggest that the declines in the teacher production rates are likely to accelerate. From this perspective, even the third set of projections appears to overestimate the likely future supplies of eligible new graduates.

The fourth and fifth sets of projections attempt to take into account the sharp declines in interest in a teaching career among entering college freshmen. Since we have little evidence on the relationship between the career choices expressed by entering college freshmen and their subsequent behavior, these projections are highly speculative. However, the commonsense notions that a freshmen disinterested in a teaching career is not likely to enter a teacher preparation program and that the rate of transfer from nonteacher preparation programs into teacher preparation programs is not likely to increase in a teacher surplus situation suggest that the career choices of entering college freshmen are meaningful indicators of likely future trends in teacher production rates. In sum, taking account of our results in estimating the career choice model and the ACE data, the fourth and fifth sets of projections are not unreasonable.

These results suggest that the rate of decline in the annual teacher production rates is likely to be significantly larger than the rate of growth in the annual numbers of new college graduates. Thus, there is good reason to expect that the annual supplies of new teachers will decline sharply throughout the 1970s.

The sixth and seventh sets of projections indicate the potential impacts of overestimating the annual sizes of the BA degree class. They show that if the projections of the annual numbers of BA degree recipients have been overestimated, the magnitudes of the declines in the annual supplies of new teachers will be even greater.

THE SUPPLY OF RESERVE TEACHERS

The supply of reserve teachers in any year is defined as the number of persons qualified to teach (but not employed in teaching positions) the previous year who seek teaching positions in that year. Consequently, the two elements that enter into a projection of the reserve supply are the size of the reserve pool and the proportion of those in the pool who seek teaching positions. The size of the reserve pool, in turn, depends upon the annual rates of entry into and exit from the pool. *The results outlined above suggest that the previous studies have overestimated the annual supplies from the reserve pool since an overprojection of the number of new teachers produced in any year results in an overprojection of the size of the reserve pool in subsequent years.*

However, because of the paucity of available data regarding the rate at which reserve teachers seek teaching positions, we cannot estimate the significance of these overprojections. To obtain an indicator of how serious the implications of these overprojections might be, we have projected the supply of reserve teachers through 1981 using a number of different sets of assumptions. The results are presented in Table 18.

Table 18

ALTERNATIVE PROJECTIONS OF THE SUPPLY OF RESERVE TEACHERS
(in thousands)

Year	Projections								
	1	2	3	4	5	6	7	8	9
1973	374.7	367.3	-317.4	330.4	329.1	117.1	113.4	113.6	94.6
1974	643.5	551.0	-130.4	379.7	362.8	142.1	130.6	122.4	102.0
1975	943.8	724.5	46.8	434.5	394.3	169.7	146.7	131.4	109.5
1976	1240.2	864.0	190.0	488.8	420.0	197.3	159.8	142.8	119.0
1977	1549.1	977.9	307.4	545.9	441.4	226.3	170.9	153.4	127.9
1978	1855.0	1053.2	387.8	602.1	455.4	254.7	178.4	165.2	137.7
1979	2156.8	1090.5	432.0	658.7	463.6	283.7	183.2	179.6	149.7
1980	2437.0	1074.1	423.0	712.7	463.3	311.5	183.8	193.4	161.2
1981	2696.0	1010.7	367.4	763.5	455.1	337.8	180.6	208.0	173.4

Alternative Projections of the Reserve Supply

We adapt Rattner's definition of the size of the reserve pool unless otherwise noted. That is, the size of the pool at the beginning of any given year is assumed to equal the sum of the numbers of new teachers produced during the previous 30 years minus the number of teachers employed in the education sector the previous year.[*] Thus we assume that the annual entry into the pool equals the number of new teachers produced the previous year and that annual exit from the pool equals the number of new teachers produced 31 years ago plus the previous year's growth in the number of teachers employed in the education sector.

The demand for teachers is generally defined as the number of classroom teachers required to maintain the past trends in the pupil/teacher ratios in public and private elementary and secondary schools. Projections of the annual demands thus depend upon the projected numbers of pupils enrolled in each case (public/private, elementary/secondary) as well as the extrapolated trends in pupil/teacher ratios. The NCES provides projections of the annual demands for teachers assuming continuance of current trends in enrollments in each case and current trends in the respective pupil/teacher ratios. These are used in some of our projections.

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[*] Note that we overestimate the size of the pool to the extent that persons who prepared to teach during the previous 30 years have died, become disabled, and so on. And we underestimate the size of the pool to the extent that persons who prepared to teach more than 30 years ago are still active. Like Rattner, we assume that these errors approximately offset one another.

The NCES obviously undercounts the number of teachers who will be employed in the education sector to the extent that administrative positions, specialists, and other nonteaching positions are held by qualified teachers. Froomkin (1971) estimates that in 1970 approximately 200,000 persons qualified to teach held nonteaching positions in schools. Greenberg and McCall (1973a, 1973b, 1974) have shown that vacant administrative and other supervisory positions tend to be filled by promotion of classroom teachers. Thus the retirement of, say, a school system's superintendent will be translated into a vacant classroom teacher's position. We also develop reserve supply projections based on the assumption that the ratio of teachers employed in nonteaching positions to teachers employed as classroom teachers in 1970 (.088) will be continued through 1981.

The rate at which reserve teachers seek teaching positions is unknown. The NEA reports that, in 1960, 18.3 percent of unemployed teachers sought to enter the education sector. While the term "unemployed" is generally used to refer to persons not employed full time and seeking full-time work, it is clear that the NEA is using the term to refer to teachers not employed in education, regardless of whether or not they are employed full time in some other activity or seeking full-time employment. We can thus interpret the NEA estimate as the rate at which reserve teachers sought teaching positions in 1960.

Rattner notes that in 1970, presumably a year of approximate balance in the market for teachers, the ratio of the reserve pool to the demand for teachers was .62. He assumes this is an "equilibrium" relationship in the sense that the number of reserve teachers who do not wish to enter the education sector will, in general, equal 62 percent of the number of teachers employed in teaching positions. Thus he assumes that the number of reserve teachers who seek positions in any year equals the number of teachers in the reserve pool in excess of .62 times the demand for teachers in that year.

We should note that this approach implies rather peculiar behavior by reserve teachers. An increase in the number of teachers demanded, in this approach, increases the number of reserve teachers not interested in a teaching position and, thus, leads to a decrease in the number of reserve teachers who seek teaching positions. Hence an increase in the relative availability of teaching positions is implicitly assumed to reduce the relative attractiveness of a teaching career for reserve teachers.

As noted earlier, Froomkin's approach appears to be reasonable, but he has not released his data. And the other studies of the supply of teachers do not even address the issue of reserve supply. Consequently, the alternative projections given below are extremely speculative.

The first set of projections reproduces the Rattner approach. We use his definition of the reserve pool and his assumption regarding the rate at which reserve teachers seek to enter teaching positions. We use his assumed teacher production rate (.35) and the NCES (1973) projection of annual BA degree classes and annual demands for teachers.

The second set of projections retains Rattner's framework, but assumes that teacher production rates decline at annual average rates equal to the annual average rates of decline, 1968-1972, in the proportion of entering college freshmen interested in teaching. (These are the rates that underlie the fourth set of new teacher supply projections in Table 17.) All other assumptions used to generate the first set of projections are retained.

Rattner's estimate of the size of the reserve pool appears to overstate its true size in two respects. First, he includes all teacher education graduates, as reported by the NEA, over a 30-year period. As we have noted, the NEA estimates of the number of teacher education graduates include MA degree recipients, many of whom were previously qualified to teach. Thus Rattner's estimate involves double counting of persons qualified to teach upon receipt of a BA degree who go on to obtain an MA in education. Since 1966 about 10 percent of the teacher education graduates reported by the NEA were MA degree recipients.

Second, Rattner assumes that the reserve pool contains all persons qualified to teach, but not employed in teaching positions. However, approximately 200,000 persons qualified to teach are employed in nonteaching positions in the education sector. Thus he overestimates the size of the reserve pool by about 200,000.

To explore the implications of these observations, the third set of projections in Table 18 was constructed. All the assumptions made in connection with the second set of projections are retained with two exceptions. The Rattner estimates of the numbers of new teacher produced annually in the 1941-1972 period were reduced by 10 percent; the annual NCES demands for teachers, 1972-1981, were increased by 8.8 percent.

The next four sets of projections (numbers 4 through 7) are based on the NEA approach to the definition of the rate at which reserve teachers annually attempt to enter teaching positions. We employ the Rattner definition of the size of the reserve pool (e.g., the sum of new teachers produced in the previous 30 years) throughout and assume that annually 18.3 percent of unemployed teachers seek to enter teaching positions. In the sets of projections numbered 4 and 6, we assume an annual teacher production rate of .35. In the fifth and seventh sets of projections, we assume that teacher production rates decline from their 1972 levels at rates equal to the annual average rates of decline in entering college freshmen interest in a teaching career over the 1968-1972 period. In the fourth and fifth sets of projections, we use the NCES estimates of the annual sizes of the BA degree class and the annual demands for teachers; we use Rattner's estimates of annual teacher production for 1941 through 1972. The NCES estimates of annual demands for teachers are each increased by 8.8 percent (teachers employed in nonteaching positions in education), and the Rattner production estimates are each reduced by 10 percent (double counting at the MA degree level) in the sixth and seventh sets of projections.

The conventional wisdom regarding reentry by reserve teachers holds that female teachers leave the profession, or never enter in the first place, in order to devote time to their families and seek reentry, or deferred entry, into teaching positions when their families no longer require full-time attention. There is no comparable hypothesis regarding male teachers who, in any event, are presumed to account for only a small proportion of reentering teachers. If this theory is correct, the rate at which reserve teachers seek reentry depends upon the proportion of reserve teachers who are female between the ages of, say, 30 and 39.

If we assume that the ratio of females to males among new teachers produced has been roughly 2 to 1, we can multiply Rattner's estimates of annual total production of new teachers (reduced by 10 percent to eliminate double counting at the MA degree level) by .66 to obtain annual estimates of the numbers of new female teachers produced each year for the past three decades. Assuming that graduation occurs at age 22, we can thus estimate the number of females qualified to teach between the ages of 30 and 39 in year t as the sum of Rattner's estimates of teacher production for the years t-18 through t-9 multiplied by .9 times .66.

Using Rattner's data and the method outlined above, we estimate that the number of women between the ages of 30 and 39 who were prepared to teach in 1960 was 393,000. Froomkin estimates the number of female teachers in that age group employed in education that year as 196,000. Thus the reserve pool in 1960 contained about one-half (197,000) of the women between 30 and 39 years of age who were qualified to teach. The NEA reports that in 1960 about 56,000 reserve teachers sought teaching positions. In sum, the ratio of the number of reserve teachers who sought positions to the size of the key component of the reserve pool--women between the ages of 30 and 39--was about .286 in 1960.

The last two sets of projections in Table 18 are based on the assumption that this ratio is roughly constant over time. In developing the projection for each year t, we calculate the number of females who graduated prepared to teach during the years t-18 and t-9. For this purpose we use 60 percent (.9 times .66) of Rattner's estimate of annual teacher production through 1972. We estimate annual female teacher production in the years following 1973 by multiplying the NCES (1973) projections of annual female BA degree classes by the production rates for female teachers that reflect the annual average declines in entering female freshmen expectations regarding a teaching career. We assume that annually one-half of the group is employed in teaching positions, and thus estimate the number of females between 30 and 39 years of age in the reserve pool as one-half of the total size of the group. In the eighth (ninth) set of projections, we assume that the total reserve supply, which includes both men and women younger than 30 or older than 39, equals 30 (25) percent of the estimated number of women aged 30 through 39 in the reserve pool.

Discussion of the Projections

Our lack of data regarding the reserve pool and the behavior of the teachers in that pool is reflected in the alternative projections of the reserve supply presented in Table 18. Each of the sets of projections was based on assumptions and parameter estimates that had been used in previous studies. Yet the results vary widely, depending upon how the various assumptions are combined to generate a set of projections. Moreover, there is good reason to question all the assumptions and estimates. Today there are presumably numerous persons who want to teach but are unable to find a teaching position and are thus included involuntarily in the reserve pool. There were few, if any, of these persons before 1970. This basic change in the nature of the reserve pool raises doubts as to the accuracy of any of the parameter estimates based upon pre-1970 experience.

Despite our inability to project the reserve supply with any degree of confidence, the alternative sets of projections presented in Table 18 give a rough indication of how the anticipated continued decline in teacher production rates influences the reserve supply. The first set of projections in Table 18 follows Rattner's procedure. The second set deviates from the Rattner procedure in only one respect: Over the 1973-1981 period, the teacher production rates are assumed to decline from their 1972 levels in the latter, whereas they were assumed to be constant (.35) in the former. Comparing the two sets of projections we can see that this change in the assumed future values of the teacher production rate has a great impact on the projected supplies of reserve teachers.*

The fourth and fifth sets of projections are based on the assumption that 18.3 percent (the NEA estimate) of reserve teachers annually seek positions. Otherwise, they incorporate all the assumptions that underlie the first and second sets of projections, respectively. Thus comparison of the first and fourth sets of projections indicates the impact of changing from the Rattner definition of the annual rate at which reserve teachers seek positions to the NEA definition when the teacher production rate is assumed to be 35 percent. Similarly, the difference between the second and the fifth sets of projections indicates the effect of changing from the Rattner definition to the NEA definition when the teacher production rates are assumed to decline at the average annual rates of decline in entering freshmen interest in teaching. In both cases it is clear that the NEA approach yields far lower estimates of the supply of reserve teachers than does the Rattner approach.

The difference between the fourth and fifth sets of projections indicates the impact of the anticipated decline in teacher production rates when the NEA approach is employed. While the magnitude of the impact is smaller in the NEA approach than in the Rattner approach (the difference between the first and second sets of projections), it is nonetheless very large.

The third, sixth, and seventh sets of projections parallel the second, fourth, and fifth sets, respectively. In each case, annual demands for teachers are revised upward by 8.8 percent (to reflect the employment of teachers in nonteaching positions in the education sector) and the annual numbers of new teachers produced before 1972 are reduced by 10 percent (to reflect the presumed double counting of MA degree recipients). Otherwise, the respective assumptions are unchanged. Again, we can see that the Rattner approach generates larger annual estimates of the reserve supply than does the NEA approach. (Compare the third and the seventh sets of projections.) We can also see that the impact of the anticipated decline in teacher production rates upon the annual supplies of reserve teachers is substantial. (Compare the sixth and seventh sets of projections.)

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*This difference illustrates the problem with the Rattner definition. If the size of the reserve pool exceeds 62 percent of the demand for teachers, all increases in its size are translated one-to-one into increases in the reserve supply.

The eighth and ninth sets of projections depend upon the assumption that reentry of female teachers between 30 and 39 years of age dominates the reserve supply. Note that the teachers in question through 1981 have already been produced. These projections thus illustrate one case in which the values of the teacher production rates in the 1973-1981 period do not influence the reserve supply during that period. They will, of course, have a decided influence on the reserve supply thereafter. While this hypothesis accords with traditional notions, we are aware of no evidence that either supports or refutes it.

THE TEACHER SURPLUS

We have shown that teacher production rates are likely to decline throughout the decade. This, in turn, implies that the annual numbers of new teachers produced and the annual supplies of new and reserve teachers have been substantially overprojected in the previous studies. To place these results in perspective we now examine how the anticipated declines in teacher production rates might affect the teacher surplus. Since data limitations preclude projection of the surplus with any degree of confidence, we again resort to the device of projecting the surplus under a variety of different assumptions.

The teacher surplus is defined as the sum of the three components of supply minus the demand for teachers. We therefore briefly consider the continuing supply of teachers before turning to the surplus projections.

The Continuing Supply of Teachers

The continuing supply of teachers is defined as the number of teachers employed in the education sector multiplied by 1 minus the teacher termination rate. In a surplus situation the number of teachers employed in the education sector is approximately equal to the demand for teachers. Previous studies have assumed that the teacher turnover rate is 8 percent. This estimate is based on data collected in the late 1950s. Keeler (1973) argues that changes in the age distribution of teachers since 1960 will result in a substantially lower rate of teacher terminations during the 1970s and early 1980s. He suggests that a turnover rate of about 5 percent will prove to be a more accurate projection. The implication of the change in the assumed value of the termination rate is clear, and we do not provide explicit projections.

Alternative Projections

Even with due regard for consistency of assumptions among the supply components, it is apparent that a large number of different teacher surplus projections could be generated with little difficulty. We are primarily concerned with the impact of the anticipated decline in teacher production rates and will focus our attention on that issue. Accordingly, in Table 19 the various sets of projections are presented in pairs in which all assumptions except for the assumed values of the teacher production rates will be maintained in both sets of projections in each pair. The teacher production rate is assumed to be constant at .35 in the first set of projections (version "a") in each pair. Teacher production rates are assumed to decline at rates equal to the annual average rates of decline (sex- and level-specific) in interest in teaching among entering freshmen in the second set of projections (version "b") in each pair. We assume, in the first set of each pair, that 72 percent of the new graduates eligible to teach seek positions. In the second set of projections in each pair we assume that 81 (65.1) percent of the new graduates prepared to teach at the elementary (secondary) level seek positions.

Table 19

ALTERNATIVE PROJECTIONS OF THE TEACHER SURPLUS
(in thousands)

Year	Projections					
	1a	1b	2a	2b	3a	3b
1973	422.1	351.0	148.5	81.1	224.5	157.1
1974	699.0	512.0	181.6	75.6	256.6	150.6
1975	999.7	663.5	209.6	69.7	284.6	144.7
1976	1306.9	785.9	248.0	65.7	328.0	141.7
1977	1624.9	884.8	285.0	58.8	360.0	133.8
1978	1946.9	949.9	330.6	58.7	405.6	133.7
1979	2251.8	966.6	360.7	41.3	436.7	117.3
1980	2527.4	927.1	382.9	17.8	458.9	93.8
1981	3085.7	846.6	408.5	-2.3	485.5	74.7

We use the NCES projections of the annual sizes of the BA degree class in every case. The NCES projections of annual demands for teachers and Rattner's estimates of teacher production 1941-1970 are used in the first pair of projections. In all subsequent pairs we revise the NCES demand projections upward 8.8 percent and the Rattner production estimates downward 10 percent. We use the Rattner definition of the size of the reserve pool in every case.

The first pair of projections assumes a teacher turnover rate of 8 percent and uses the Rattner definition of the rate at which reserve teachers seek positions. The second and third pairs of projections assume teacher termination rates of 8 and 5 percent, respectively. The NEA assumption that 18.3 percent of the reserve teachers annually seek teaching positions is used in the latter two pairs.

The Results

The set of projections labeled 1a is based upon Rattner's assumptions without exception. Rattner, however, reports that the projected teacher surplus in 1980 is 1.5 million. We cannot explain the difference. In any event, our main interest is in the difference between the "a" and "b" versions of each pair of projections. *It is clear that regardless of what other assumptions are made, if the anticipated declines in teacher production rates materialize, the magnitude of the teacher surplus will be greatly affected.*

LONG-TERM IMPLICATIONS

The lag structure of the educational personnel system imparts considerable inertia to the supply of teachers. The current level of teacher production depends upon the career choices made by the students who entered college four or more years ago. The size of the reserve pool, given the demand for teachers, depends upon the career choices made by college entrants throughout the past three and one-half decades. And its size will change from one year to the next only to the extent that current teacher production differs from the sum of the current change in the total demand for teachers and teacher production about 30 years ago.

Suppose we are correct in assuming that teacher production rates will continue to decline as long as the surplus persists. Growth in the annual size of the BA degree class will offset a part of the decline in the teacher production rate. The annual numbers of new teachers produced will then decline, but at a less rapid rate than the teacher production rate. Assuming that demand is roughly stable, the reserve pool will continue to grow until the number of new teachers produced falls below the level of teacher production 30 years earlier. Thus the reserve supply will grow, partially offsetting the decline in the supply of new teachers. Of course, if teacher production rates continue to fall, the point where the reserve pool begins to contract will eventually come. Even then, if the reserve pool is "large," the sum of the reserve supply and the new supply will still exceed the net demand for teachers. Hence the teacher surplus will persist, albeit declining in size, in spite of declines in both the new and reserve supplies of teachers. Sooner or later, if nothing occurs to disturb these trends, the surplus will disappear.

The emergence of the current surplus provides an excellent example of the inertia in the system. As we have seen, entering college freshmen began to respond almost immediately to the downturn in the employment prospects of teachers. The proportion of entering college freshmen who intended to pursue a career in teaching grew through 1968 or 1969, when the surplus appeared, and then dropped dramatically. Even if we assume, as we do, that these declines in interest by freshmen will be translated into declines in the teacher production rates, we still project continuance of the surplus through 1980 (see projection set 2b in Table 19). And if other factors intervene (e.g., a decline in the teacher termination rate), the surplus would continue three or four years beyond that date (see projection set 3b in Table 19).

The important point is that this inertia works in the opposite direction as well. Suppose that the process described above proceeds to the point that the surplus is ended in, say, 1983. The situation in that year will be approximate equality between the net demand and the sum of reserve supply and new supply. But that balance was achieved through declines in both components of supply. And those declines will continue, at least for a while. The students who entered college in the preceding two or three years will have made curriculum choices during a period of teacher surplus and, presumably, only a small proportion of them will have entered teacher preparation programs. Thus the annual numbers of new teachers produced will continue to decline, the reserve pool will contract further, and the supply of teachers will decrease. After three or four years, the college students who entered after the end of the surplus will begin to graduate, and both teacher production and annual new supplies of teachers will begin to grow. But the reserve pool and the supply of reserve teachers will continue to contract until new teacher production increases to levels greater than the levels of new teacher production 30 years earlier. And since the surplus is not likely to end until teacher production has fallen well below the levels of 30 years ago, this increase will take time. Thus continued decline in the reserve supply will continue for some time after the new supply has begun to increase and will, for that time, partially offset increases in the new supply. And increases in the new supply are likely to themselves lag behind the end of the surplus.

In sum, it appears that if and when the surplus ends, the inertia in the system will lead to the almost immediate onset of a teacher shortage.

Appendix A

PROJECTIONS OF THE DEMAND FOR TEACHERS

AVAILABLE STUDIES

The available projections of the demand for teachers (Table 2) are remarkably similar. The ranges in the projections of the total demand for classroom teachers for 1975 and 1980 are less than 1.2 percent of the total. The range in the 1980 projected demand for new hires is also quite small -- less than 4 percent. For 1975, however, the largest projected demand for new hires (211,000 from the Commission on Human Resources and Advanced Education) is about 30 percent greater than the smallest projection (162,000 from NCES). Part of this discrepancy may have been caused by the difference in the base periods used. The Commission's base period ended in 1965, while the DOL and NCES projections incorporated data through 1969.

The remarkable similarity in the projections of total teacher demand results from the application of a common methodology to similar data bases. The common methodology was to extrapolate trends in two key aggregate parameters -- the enrollment rate per age group and the average pupil/teacher ratio -- and use these to estimate the total demand for teachers. These two parameters are combined with census population projections by age group to obtain estimates of the total demand for teachers using the following identity:

$$D_t = \frac{\sum_i G_{it}\delta_{it}}{\frac{P}{T_t}} ,$$

where D_t = total number of classroom teachers demanded in year t,

G_{it} = number of persons of age i in year t,

δ_{it} = enrollment rate of the ith age group in year t, and

P/T_t = average pupil/teacher ratio in year t.

Changes in the projected total demand for classroom teacher depend directly on changes in the projected size of the population by age group and the respective age-specific enrollment rates and inversely on projected changes in the pupil/teacher ratio.

The net demand for new teachers is projected by NEA, the Commission, NCES, and DOL, using a simple two-equation system:

$$N_t = D_t - D_{t-1} + L_t$$

$$L_t = r\ T_{t-1}\ ,$$

where T_t = number of teachers employed (in education) in year t,
N_t = net teacher demand in year t,
L_t = teacher losses in year t, and
r = turnover rate.

In sum, net teacher demand in year t equals the change from the previous year in the total number of teachers demanded plus the number of teachers who left the system and must be replaced. Teacher losses are assumed to be a constant proportion of the stock of teachers.

All four studies implicitly used these equations but employed slightly different teacher turnover rates, r. The NEA estimated a different turnover rate for elementary and secondary teachers. The weighted average NEA turnover rate was 8.33 percent compared with the aggregate estimate of 8.0 percent used by the Commission and NCES. The DOL did not state its assumed turnover rate. Other differences in the estimates primarily reflect the different data bases used.

ASSESSMENT OF THE DEMAND STUDIES

As we have seen, the available studies of the demand for teachers are based upon assumed trends in enrollment levels, the pupil/teacher ratio, and, in the case of studies that focus on net demand, the teacher turnover rate. Hence the reliability of those studies depends upon the accuracy of those assumptions.

Enrollment Levels

With respect to enrollment levels, changes in the size of particular population age groups depend upon broad demographic factors such as birth rates, death rates, and the size of the female population in childbearing age groups. Since these factors are not affected by specific conditions within the teacher labor market, their specific values can be projected independently. Moreover, projections of teacher demand over the next five to ten years are not very sensitive to changes in the assumed size of these demographic factors, because the effects of changes in birth rates are felt only after a substantial delay. For example, enrollment projections based on the two principal population projections of the U.S. Bureau of the Census (Series C and Series E), which differ only in the assumed birth rates, 2.78 and 2.11 per 1000 population, respectively, show almost no effect on the school-age population in 1975, and even by 1980, there is only a 3.8 percent differential. Of course, lowering the minimum age for the school-age population (i.e., changing the definition of the population at risk) would produce a large one-shot impact but would not alter the basic conclusion.

In sum, future increases in age-specific enrollment rates will have only a small effect on enrollments and hence on the total demand for teachers. This is because of the very high enrollment rates prevailing for all the school-age groups except the 5-year-old group. Even if this group's enrollment rate were to increase substantially (for example, an increase to a 90-percent enrollment rate), the net effect on total 1980 enrollments would be less than 2 percent.*

Thus, although different assumptions can be made concerning the demographic factors determining population changes and the factors influencing the age-specific enrollment rates, the net effect on projected enrollments over the next ten years is small. Because of this insensitivity, enrollment projections are relatively stable and certain over a period of five to ten years.

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*This estimate was obtained using the Series C projection for the 5-to-6-year-old group. Assuming there would be 4,500,000 5-year olds in 1980, the .127 enrollment differential would cause an enrollment increase of approximately 571,500, compared to the total school-age enrollment of 49,858,000.

Pupil/Teacher Ratios

Although enrollment projections may be relatively stable over a ten-year period and basically independent of conditions within the teacher labor market, the pupil/teacher ratio projections are an entirely different matter. First, the impact on total demand from a change in one of the determinants of the pupil/teacher ratio is realized more quickly than the enrollment impact of a change in a demographic factor such as the birth rate. Because there is no long lag between a factor's change and the impact of that change, total teacher demand is immediately sensitive to differences in the assumptions affecting the pupil/teacher ratio. Second, the potential magnitude of the impact of a change in the pupil/teacher ratio is not constrained as is the impact of a change in the age-specific enrollment rates. The pupil/teacher ratio can change substantially in either direction, whereas most of the age-specific enrollment rates are already so high (.98 or above) that further potential increases would be negligible. Given this greater potential sensitivity and more immediate response, the pupil/teacher ratio is clearly a key parameter in five-to-ten-year projections of total teacher demand.

The sensitivity of the total teacher demand to changes in the pupil/teacher ratio is easily illustrated. The 1975 enrollment level from the Census Series C projection is 49,559,000. Rattner estimates that the pupil/teacher ratio in that year will be 22.38, yielding a total demand for teachers of 2,214,400. A decrease of one in the projected pupil/teacher ratio (i.e., to 21.38) would yield a projected total teacher demand of 2,318,000, an increase of 103,600. In sum, a 4.5-percent decrease in the projected pupil/teacher ratio would result in a 4.7-percent increase in the projected demand for teachers.

The district's demand for teachers is determined by means of a complex budget allocation process. Given the relative stability of enrollment rates, the district's pupil/teacher ratio is thus also determined. Since the outcome of the budget allocation process depends upon the size of the district's budget and the set of input prices it faces as well as its own preferences, past trends in pupil/teacher ratios can be assumed to continue into the future only if it is assumed that both district budgets and input prices change in a consistent manner. In light of the prospects for reform of school finance, the emergence of militant teachers' unions, the current fiscal problems of many districts, and so on, this would seem to be an untenable assumption.*

Termination Rates

The four studies that focus on the annual net demands for teachers employ an additional parameter -- the teacher termination rate. In each case it is assumed that a constant proportion of the stock of teachers will leave the profession each year. Unfortunately this assumption does not appear to be warranted. In the first place, many teacher terminations result from decisions to leave teaching for a short period of time rather than permanently. Women who temporarily "retire" in mid-career to devote more time to their families are a prime example. In conditions of general surplus, reentry is undoubtedly more difficult than had been the case when teacher shortages prevailed. Such informal "leaves of absence" are likely to decline in view of the changed nature of the market for teachers.

The second reason for expecting reduced rates of termination in the future is related to the demographic characteristics of the teaching force. The rapid growth in enrollments that occurred in the 1950s and early 1960s generated equally rapid growth in the teacher force. Large numbers of beginning teachers entered the profession each year and the average age of the force declined. In the near term, retirement rates are thus likely to decline, although this drop should be only temporary and retirements in the 1980s are apt to occur at high rates.

Keeler (1973) has reviewed the available studies of teacher termination and shows that termination rates have fluctuated between 7 and 10 percent in the 1960s with no apparent trend. However, he argues that overall rates of termination are likely to fall in the 1970s, perhaps by 2 to 3 percentage points.

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*See Carroll (1973) for a detailed analysis of the relationships between the districts' budgets and teachers' salary levels, on the one hand, and the demand for teachers, on the other hand.

This is an important point because the net demand for teachers is sensitive to the termination rate. In 1975, for example, the studies reviewed here project a total demand for roughly 2.3 million teachers (see Table 2). A change of one percentage point in the teacher termination rate, say from 8 percent to 7 percent, would reduce the net demand for teachers by about 23,000. This represents a 10- to 15-percent reduction in the net demand for teachers.

SUMMARY

In summary, our analysis has demonstrated that there are few problems with the enrollment variables used because of the general insensitivity of the estimates to potential changes in the variables. There are, however, serious questions regarding the use of trend extrapolation to project the aggregate pupil/teacher ratio and the termination rate.* For valid trend projection, the basic conditions underlying specific trends must be the same in the projection period as they were during the base period. The fundamental change in the market for teachers that occurred in the late 1960s violates this requirement.

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*The reader is referred to Carroll (1973) and Keeler (1973) for more detailed analyses of the demand for teachers and teacher termination, respectively.

Appendix B

DATA AVAILABILITY AND DATA GAPS

In this appendix we define the specific variables used in our state cross-sectional estimates of the long-run teacher supply (i.e. the determinants of the pool of eligible new graduates) and document the data sources used. We also identify several severe quantitative and qualitative gaps in the data currently available and suggest some alternatives for eliminating these gaps.

DESCRIPTION OF VARIABLES AND DATA SOURCES

Table 20 summarizes the variables and their data sources used in our empirical estimates of teacher production reates. There were alternative sources for three types of teacher data. We will briefly indicate the reasons for our choice of source before examining the data gaps in detail.

The number of BA graduates eligible to teach could have been approximated using data from one of three sources: *Teacher Productivity*, an annual publication put out by the American Association of Colleges for Teacher Education (AACTE), *Earned Degrees Conferred*, published by the Office of Education (OE), or *Teacher Supply and Demand in Public Schools*, by the National Education Association (NEA).

The AACTE source had two disadvantages. First, the AACTE surveyed only its own membership and a few nonmember institutions. Although these institutions produced more than 90 percent of all teacher education graduates, the survey was not all inclusive. Second, the AACTE ceased publishing its annual report in 1968. The decision was made to use the NEA source rather than OE's *Earned Degrees Conferred* (Higher Education General Information Survey, HEGIS) because (1) the number of education degrees reported by OE is significantly less than the total number of BAs eligible to teach since those prepared to teach an academic subject are not included in the education, prepared-to-teach, subtotal, and (2) the OE estimates for education degrees are not disaggregated to the state level. The difference in this total estimate is quite large. For example, for the period from 1969 to 1970, OE estimated 166,423 BA "education degrees," whereas NEA estimated

Table 20

DEFINITIONS AND SOURCES OF VARIABLES

Variable	Definition	Source
Dependent		
$P_t = \frac{(ELG)}{(BA)}$	Proportion of BA graduates eligible to teach	----
ELG	Number of male (female) BAs eligible to teach elementary/secondary grades	NEA, *Teacher Supply and Demand in Public Schools*
BA	Number of male (female) BA graduates	OE, *Earned Degrees Conferred*
Independent		
$rw = TW/AW$	Relative wages teachers/alternative	----
TW	Average elementary (secondary) classroom teacher salary	NEA, *Estimates of School Statistics*
AW	Average salary of state and local government welfare workers	U.S. Department of Commerce, *Public Employment in 19XX*
$rpr = \frac{\Delta TN-\Delta ELG}{\Delta TN} \Big/ \frac{\Delta AN-\Delta BA}{\Delta AN}$	Relative teacher to alternative employment opportunity	----
TN	Number of full time elementary and secondary classroom teachers	NCES, *Statistics of Public and Nonpublic Elementary and secondary Day Schools*
AN	Total state employment in government and services sector	BLS, *Employment Earnings: States and Areas 1939-1970*
$PR = \frac{\Delta TN}{\Delta AN}$	Relative change in employment; a proxy for employment security	----
RUR	Proportion of state population in rural areas	U.S. Bureau of the Census, *Statistical Abstract of the U.S., 1969*
HE	Student enrollment in private relative to public institutions of higher education	U.S. Bureau of the Census, *Statistical Abstract of the U.S., 1969*
PCY	State per capita income	U.S. Bureau of the Census, *Statistical Abstract of the U.S. 1969*
$NMIX = \frac{TN}{AN}$	Employment mix proxy	----
CRED	Number of professional hours for elementary (secondary) certification	NEA, *A Manual for Certification Requirements for School Personnel in the United States*

251,578 BAs "eligible to teach" from the 1970 graduates, a difference of more than 85,000.

Teacher salaries are reported in two NCES publication: *Statistics of Public and Nonpublic Elementary and Secondary Day Schools*, and *State School Systems*. The NEA source is preferable, however, because the former does not distinguish between elementary and secondary average classroom teacher salary; the latter contains only average salary of instructional staff, even though the survey form collects raw data for elementary and secondary average classroom teacher salary. The NEA source is also preferable to data from OE's Elementary and Secondary General Information Survey (ELSEGIS), because the survey does not distinguish between average classroom teacher salary and average salary of professional instructional staff.

The number of classroom teachers employed is reported in numerous NCES and NEA publications. Our choice of source depended principally upon our use of only full-time employed classroom teachers in public elementary and secondary schools. We used the number of full-time elementary and secondary classroom teachers rather than total full- and part-time teachers or full-time equivalent teachers because most college graduates eligible to teach were assumed to enter the labor market seeking full-time employment, not part-time work.

Our data source, the NCES publication, *Statistics of Public Elementary and Secondary Day Schools*, was preferred to ELSEGIS data because (1) state summaries were available and (2) historical data were available. It was preferred to the biennial survey data (published in *State School Systems*) because it provided (1) annual data and (2) data on full-time and part-time classroom teachers, not simply full-time equivalents (FTE's). The NCES's *Statistics of Public and Nonpublic Elementary and Secondary Day Schools* was also superior to the NEA's *Estimates of School Statistics* because (1) the NEA data are estimates of uncertain reliability and (2) the NEA data do not distinguish between full- and part-time teachers.

DATA GAPS

Throughout our report, we cited data gaps that restricted our ability to develop reliable alternative estimates of the future national supply of teachers. We summarize the major gaps in this appendix, indicate the importance of the gaps, and suggest some alternatives for eliminating them. We should also note, however, that some of these gaps are eliminated at lower levels of aggregation. That is, some states have data that would permit a more complete analysis of the determinants of the long-run supply of teachers for that state. Our work with data from the State of Michigan exemplifies this potential and also indicates some of the difficulties inherent in this disaggregated approach.*

At the national level, the principal data gaps are:

- Size and composition of the reserve pool,
- Number and characteristics of new teachers produced,
- Number and characteristics of newly hired classroom teachers,
- Occupational status of individuals qualified to teach and not employed in education,
- Average starting salary levels in education and in alternative occupations, and
- Nature of the local labor market.

Some of these gaps are more critical than others; some constitute only a qualitative gap; and many can be eliminated without substantial cost.

Size and Composition of the Active and Inactive Reserve Pools

The most critical gap in the data is the lack of information regarding the size of the active and inactive reserve pools. The Rattner approach--cumulating new graduates eligible to teach over a sufficient period of time, adjusting for mortality and other attrition factors, and substracting the stock of teachers currently employed in the education sector--provides a gross measure of the size of the total reserve pool. But this method, of course, tells us nothing about the relative sizes of the active and inactive segments of the pool, or, alternatively, the proportion of persons in that pool actively seeking teaching positions.

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*See Greenberg and McCall (1974).

Population surveys can, of course, be used to estimate the size of the reserve pool and the distribution of persons in that pool between active and inactive status. However, estimating the distribution at some time in the past is not the important question: Estimates of future distribution are needed. We have to be able to project the sizes of the two segments of the pool (active and inactive) with some reasonable degree of accuracy, which requires the capability to extrapolate individual behavior into the future. This, in turn, requires identification of the factors that influence individuals' behavior and the ways in which individuals respond to those factors.

There are two approaches to the acquisition of this information. One, the inferential approach, is to develop and empirically estimate statistical models of reserve teachers' behavior. (Our analysis of career choice in Section IV is an example.) For this purpose, longitudinal data (perhaps obtained retrospectively) on the activities of a group of reserve teachers would have to be collected and analyzed. Collection and analysis of extensive cross-sectional data on the activities of a group of reserve teachers would be a decidedly inferior, but less expensive and more rapidly implemented alternative.

The second approach is to obtain, through surveys, individuals' estimates regarding the factors that influence their behavior. Note that in this case the survey instrument must be designed to elicit responses to "what if . . ." questions. Specifically, data on whether or not individuals in the reserve pool intend to seek a teaching position at some future time is not the issue. Rather, identification of the conditions under which they would seek positions is required.

In either case, disaggregated estimates will be needed. Different "types" of reserve teachers (men/women; old/middle-aged/young; employed in other labor force activities/in the labor force, but not employed/not in the labor force; and so on) are apt to respond to different sets of factors or to respond to a given set of factors in different ways. Thus, the impact of changes in the factors that influence the behavior of reserve teachers will vary with the composition of the pool.

New Teacher Production

The second critical gap, after the lack of data on the reserve pool, is the lack of reliable data on the annual numbers of new teachers produced. Although NEA data on the numbers of new graduates eligible to teach are available, these data are disturbingly inconsistent. They do not distinguish between initially qualified new graduates and previously qualified personnel who are expanding or upgrading their skills. And they do not identify the number of persons who qualify to teach, but are not "new graduates," e.g., the person who was not qualified to teach upon graduation but who meets certification requirements through a series of summer and/or evening courses. We have already commented on the inadequacies of the HEGIS and AACTE data. In sum, we do not know how many new teachers are produced each year.

The Office of Education could eliminate the qualitative problem by making some small changes in part B of its HEGIS survey. The education or education-related degree totals should include those who are prepared to teach an academic subject, like English, Mathematics, etc. The current education total could remain to avoid double-counting, but another total (excluded from the total degree summation) should be added to show the total number of BAs and other degrees prepared to teach in all subjects. Since these data are gathered at the institutional level, a summary table of BAs eligible to teach by state could be presented in *Earned Degrees Conferred*. This would at least provide accurate counts of the numbers of new graduates who are prepared to teach.

A related data gap is the lack of information on the type of new hires. The distinction between beginning and experienced teachers is important, since it will distinguish between flows emanating from the pool of eligible new graduates and the reserve pool. It will also provide some evidence about school district hiring preferences and about the actual number of annual losses from the state or school district teacher manpower system exclusive of transfers. To provide a completely accurate measure, however, other information is needed--the number of experienced teachers hired who worked as teachers (in another system) the previous year.

These three inputs,

- o Number of new hires,
- o Distribution of new hires between experienced teachers and first-year teachers, and
- o Distribution of experienced teachers between those who worked as teachers last year and others,

will help fill a serious void in the current teacher manpower statistics. They could be obtained by adding three additional questions to (1) the surveys used to collect data on public schools (*Statistics of Public and Nonpublic Elementary and Secondary Day Schools*) and (2) the ELSEGIS survey, if local district data are desired. For aggregate data needs, the ELSEGIS survey should suffice.

Occupational Status of Reserve Teachers

Our lack of information on the activities in which reserve teachers are engaged is serious. Reserve teachers who have entered upon alternative careers are much less likely to attempt to enter a teaching position than are reserve teachers who have accepted a job to which they have no commitment because they were unable to enter the education sector. This point is particularly important at the present time since the current surplus has forced large numbers of new graduates who normally would have entered teaching into alternative employment instead. If a large proportion of such persons abandon their teaching aspirations, the reserve pool in the future will be substantially smaller than would be the case if these persons generally view their alternative employment as temporary. Homemaking is, of course, included in the notion of occupation as used here.

There are some special problems that arise when dealing with education degree recipients above the BA level. The first is determining whether the degree represents initial teaching eligibility for the recipient. Information on the number of post graduate education degrees representing initial teaching eligibility would permit an important distribution between those recipients currently in the stock of qualified teachers (whether employed as teachers or not) and those in the pool of eligible new graduates. Additional data on the employment status of post graduate education degree recipients, especially the number currently employed as teachers, would provide an indication of relative skill upgrading among the current stock of employed teachers and those in the reserve pool. Indeed, the number of teachers in the reserve pool upgrading their skills may indicate a change from inactive to active status. Neither of these two additional data elements is as critical as the need for reliable estimates of the annual number of new graduates eligible to teach. Of the two, however, the distinction between those post graduates with education degrees receiving initial teaching eligibility and those already eligible to teach is the more important data.

The problem of estimating the number of persons not in degree programs who are preparing to teach is more difficult. We are not aware of any readily available source of data on such persons, and they probably represent a small or insignificant part of the total number of persons preparing to teach.

Number and Characteristics of New Hires

A serious gap in the available data is the lack of any information on either the number of new hires or the number of quits (for whatever reason). Consequently, we cannot now accurately measure flows into or out of the stock of employed teachers. Both types of data are not needed, however, since by definition the number of new hires will equal the change in the stock plus the number of quits (teacher losses). Teacher stocks (employment) are collected and published in numerous sources. Estimates of the number of new hires could be easily obtained by adding another question to the *Statistics of Public and Nonpublic Elementary and Secondary Day Schools* report on membership and teachers or the ELSEGIS survey. Estimates of teacher turnover or teacher losses could then be obtained by subtracting the change in stock from new hires by state.

In addition, if large numbers of teachers are concentrated in one or more occupations, then conditions in that occupation become an important concern. Suppose, for example, that persons trained to teach but unable or unwilling to enter teaching positions enter social work. Then significant expansion or contraction of the level of employment in social work will affect the supply of teachers.

Salary Levels

Reliable measures of teacher starting salaries, by degree level, are not available at levels of aggregation between the national average and the individual district. The starting salaries received by new graduates prepared to teach and by new graduates not prepared to teach are not available at any level of aggregation. Thus we have no idea whatsoever of the relative economic rewards of teaching vis-à-vis alternative occupations. Yet the expectations of college students in this regard clearly affect their decisions as to whether or not they will prepare to teach.

The lack of data on starting salaries for teachers could easily be eliminated using either *Statistics* or the ELSEGIS survey instruments. Two additional data elements--maximum teacher's salary and years experience associated with that maximum--would provide sufficient information to approximate the average career earnings for teachers. This would afford a more accurate representation of the monetary return to a teaching career than currently available average classroom teacher salary data. Similar data for nonteaching alternatives would have to be obtained through the survey.

The Local Labor Markets

Despite the complexity of the system illustrated (or implied) in Figure 1, the diagram remains a gross oversimplication of the complete national educational manpower system. Rather than one unified national system as Figure 1 suggests, the educational manpower system is in reality a series of local systems, whose boundaries are not well defined and whose interconnections are likewise poorly defined but multitudinous. Figure 1, for example, might reflect a "closed" areawide system. An "open" system would require, at a minimum, additional flows reflecting interarea mobility within the education sector, between a reserve pool in one state or metropolitan area and the education sector in another or vice versa, and between persons qualified to teach in one location and the reserve pool or the education sector in another. Of course, the local labor market is not solely defined in geographical terms. It has a skill dimension as well. Thus flows between teaching and other professional positions in education, which may or may not be accompanied by a locational move, are also relevant. Similarly, flows are included between teaching in one subject area at one level and teaching in or at another and flows from teacher preparation programs in one substantive field to teaching positions in different fields.

From a national perspective these complexities might appear to be irrelevant. And they probably are, so long as the surplus (or, at another time, the shortage) is very large. But as the size of an overall imbalance in the market declines, the nature of local labor markets becomes an increasingly important issue. It is easily conceivable that balance of supply and demand at the national level can be accompanied by large surpluses and shortages at the local level.

The NEA provides data on the numbers of eligible new graduates by substantive field and by state. The interrelationships (eligible new graduates by field in each state) are presumably available in the raw data, but are not published. The NEA also publishes data on the number of eligible new graduates in each state who enter teaching positions in some other state. The interstate flows are presumably available in the data, but, again, are not published. Greenberg and McCall (1973a, 1974) provide estimates of flows among assignments and schools both within districts and within a state. However, these sources only begin to scratch the surface of what is needed.

The changes in HEGIS suggested above would provide data on new graduates eligible to teach by field and institution. We have also suggested the collection of data on new hires by district. If the latter data also identified the institution at which each newly hired new graduate was trained, these two data bases could be combined in analysis of the scope of local labor markets.

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